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PACIFIC SCIENCE

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(Continued on inside back cover)

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On Zooplankton of Some Arctic Coastal Lagoons of Northwestern Alaska, with Description of a New Species of *Eurytemora*

MARTIN W. JOHNSON[1]

A CHARACTERISTIC FEATURE of the low-lying Alaskan coast of the Chukchi Sea is the presence of a more or less broken beadlike series of "lagoons" extending from Cape Prince of Wales to Point Barrow. The general scientific interest in these lagoons is succinctly summarized by R. H. Fleming and staff in a preliminary report on the "Brown Bear" cruise no. 236 in 1959:

> The geological and oceanographic processes that have led to development and life history of these features are of major scientific interest. Because each of them may represent a variable but unique micro-environment, the biology of these lagoons is also of unusual interest because they represent a transitional series of marine to freshwater environments. At one extreme these lagoons are, in effect, the complex estuaries of rivers that flow only during the summer. At the other extreme the older lagoons, now permanently isolated from the sea and clogged with sediment and vegetation, are only distinguishable from aerial photographs. Between these two extremes are bodies of water, varying greatly in size, that must from time to time be flooded with sea water and then are closed off again and slowly diluted by the accumulation of precipitation and runoff.

During August 4–15, 1959, an opportunity was provided by the U. S. Atomic Energy Commission's Committee for Environmental Studies of Project Chariot and the University of Washington Department of Oceanography[2] to conduct a survey of the plankton in a number of these more or less landlocked lagoons situated at the immediate coast in the region of Cape Thompson, Alaska. The samples collected, being from various lagoons, are important in providing a broad picture of the deviations or similarities that characterize the populations of these bodies of water. The fauna encountered are of special interest in furthering our knowledge of the geographic distribution, biology, and taxonomic status of certain calanoid copepod species that are in varying degrees transitional between the purely marine and freshwater forms.

Prior to the initiation of this project, there had apparently been no study of the zooplankton of these remote and relatively inaccessible lagoons. Some studies that provide especially useful records for comparison have been made previously of the offshore plankton of the Alaskan coast of the Chukchi and Beaufort seas (Willey, 1920; Johnson, 1953, 1956), and in ponds situated at Point Barrow (Comita and Edmondson, 1953; Comita, 1956; Johnson, 1958). Coincident with the present restricted study, a general plankton survey was made in the offshore waters of portions of Chukchi and Bering seas by members of the University of Washington Oceanographic Department aboard the "Brown Bear" (R. H. Fleming and staff, 1959).

It is a pleasure to thank Dr. Richard H. Fleming for providing this opportunity to participate in the research expedition of the University of Washington oceanographic vessel "Brown Bear" to the Chukchi Sea area. The assistance of Dr. Norman J. Wilimovsky, Philip Buscemi, and Howard Smith in the field is gratefully acknowledged, as is also the cooperation of the administrators and contractors of the project site. The water samples were titrated for chlorinity by the Geological Survey laboratory at the project camp site.

PROCEDURE AND RESULTS

The plankton samples were collected with a 30-cm. net, 1 m. long, constructed of no. 6 bolting cloth. An inflated rubber boat was used

[1] Scripps Institution of Oceanography, University of California, La Jolla, and the University of Washington, Department of Oceanography, Seattle. Contribution from Scripps Institution of Oceanography, New Series. Manuscript received September 12, 1960.
[2] Contract AT-45-1-540 and Nonr-477 (10).

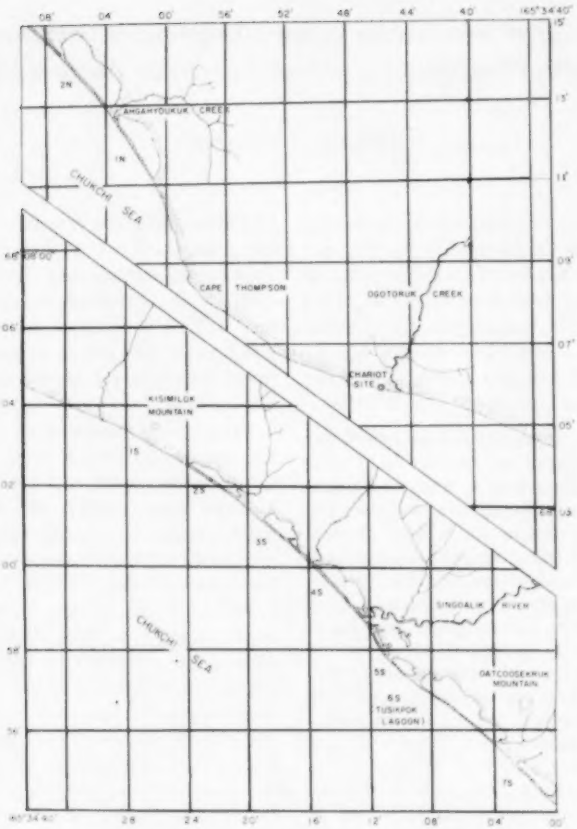


FIG. 1. Numbered lagoons sampled in the Cape Thompson, Alaska area. Based on U. S. Coast and Geodetic Survey Topographic Map T-9425 Alaska.

while obtaining the deeper hauls and the water samples. Most surface hauls were made by wading along shore with the net attached to the end of a pole.

Lagoons

The position, approximate size, and identification of the lagoons sampled are shown in Figure 1. Cape Thompson divides them geographically into a northern and a southern group, as numbered in Figure 1. The only lagoon for which a name occurs on U.S.C. and G.S. Topographic Map T-9423, on which Figure 1 is based, is Tusikpok, which corresponds to no. 6 south. All of the lagoons are shallow; the depths at the positions of sampling (about one-half the distance across the lagoon) were from 1.3 to 3 m., and, as anticipated from wind conditions and shallowness, they showed only moderate or no thermal or haline stratification except in no. 2 south where the salinity at the bottom was 1.65 per mille higher than that at the surface (Table 1). It is clear that they are at times subject to invasion of salt water from the sea. This is evidenced by the brackish water of some, by high wave-washed channels on the gravel berms separating the lagoons from the sea, and, in several instances, by the presence of marine and brackish water animals found in the plankton of some lagoons. Lagoons no. 2

TABLE 1

WATER TEMPERATURE AND SALINITY IN COASTAL LAGOONS IMMEDIATELY SOUTH AND NORTH OF CAPE THOMPSON, ALASKA, AUG. 1959

(The lower sample was taken just above the bottom depth indicated)

LAGOON	TEMP. °C.	SALINITY ‰
Lagoon no. 1 south, Aug. 12		
surface	11.0	0.83
bottom (1.5 m.)	11.0	0.83
Lagoon no. 2 south, Aug. 12		
surface	11.2	14.31
bottom (1.3 m.)	11.1	15.96
Lagoon no. 3 south, Aug. 12		
surface	11.0	0.16
bottom (2.1 m.)	10.4	0.17
Lagoon no. 4 south, Aug. 13		
surface	12.3	6.42
bottom (1.3 m.)	12.1	7.16
Lagoon no. 5 south, Aug. 13		
surface	13.6	0.83
bottom (1.3 m.)	13.6	0.83
Lagoon no. 6 south, Aug. 13		
surface	12.6	0.73
bottom (2.4 m.)	12.4	0.73
Lagoon no. 7 south, Aug. 13		
surface	12.6	3.58
bottom (2 m.)	12.1	3.58
Lagoon no. 1 north, Aug. 14		
surface	13.5	0.18
bottom (3 m.)	13.0	0.18
Lagoon no. 2 north, Aug. 15		
surface	13.8	0.46
bottom (2.5 m.)	13.0	0.55

and 4 south each have a narrow above-sea-level outlet that probably floods with sea water during high storms and undoubtedly accounts for the higher salinities observed there.

Judged by the composition of the contained zooplankton, the lagoons are strikingly dissimilar ecologically. How persistent this dissimilarity is cannot be said from this preliminary survey. Basically, the differences probably arise from the geographic position of each lagoon with respect to (1) extent of influx of fresh water in relation to the amount and frequency of that which spills over from the sea during high winds, (2) the height of the lagoon with respect to sea level, and (3) the effectiveness of the berm in serving as a barrier (reinforced by permafrost?) to water percolating out from the lagoon through the gravel. However, the environmental conditions characteristic of each lagoon have been sufficiently unique in the immediate past to permit selection and development of one or two species to a position of overwhelming dominance numerically, as shown by the analysis of the plankton fauna.

Zooplankton

The percentage composition of the fauna is shown in Table 2. Specific attention was given mainly to the calanoid copepods, because of the interest that some of the species hold as transitory forms or as permanent residents in the overlapping environmental conditions between the sea and fresh water. In all cases the populations were composed dominantly of fresh-water or brackish-water forms. But in lagoon no. 2 south, there was a conspicuous element of marine plankton, which was probably only recently recruited from the sea (Table 2). Although *Acartia bifilosa*, a brackish-water species, was overwhelmingly dominant in this lagoon, several marine copepods were also present, but no larval stages of any species were found that might indicate local production. However, if only one generation is produced each year in the lagoon, as is common in some Arctic lakes, the season of nauplii-hatching was probably about past. Most of the marine species found are considered typical of strongly neritic waters, but *Calanus finmarchicus*, *Pseudocalanus minutus*, and *Acartia longiremis* do also occur well offshore and are very common in the Chukchi Sea, especially off the eastern coast and well north into the Arctic.

Eurytemora pacifica is one of the more infrequent neritic species encountered. Rather little is known regarding its preferred habitat. Hitherto, on the Alaskan coast it has been taken only at Grantley Harbor, and in the region of Point Hope, where it was reported by Willey (1920) as *E. johanseni* n. sp. Excepting lagoon no. 2 south, it was not found in any of the present lagoons, but it was common in a tow taken immediately offshore from lagoon no. 1 north. It is also common in Kivalina Lagoon, where it constituted 7 per cent of the calanoids in a sample kindly provided by Mr. Robert W. Owen of

TABLE 2

PERCENTAGE COMPOSITION BY NUMBER OF PLANKTON IN COASTAL LAGOONS IMMEDIATELY SOUTH AND NORTH OF CAPE THOMPSON, ALASKA
(c = common; + = present, but neither in sufficiently large numbers to constitute 1 per cent of population)

	LAGOONS SOUTH														LAGOONS NORTH			
	1		2		3		4		5		6		7		1		2	
Date of sampling	6	12	6	12	6	12	6	13	6	13	6	13	6	13	14	15	5	15
Surface or bottom	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B	S	B
Arcartia bifilosa			78	90			90	12	c									
A. clausi			2						+									
A. longiremis			18	8														
Calanus finmarchicus			+															
Centropages abdominalis			c	+														
Cyclops spp.	65	12				+	+	4	c	c	2	c	+	+	c	1	1	+
Eurytemora canadensis	3					1		+	+	+	3		c	3				
E. herdmani			c	c														
E. pacifica			+	+														
E. foveola, n. sp.											95	90			99	98	57	28
Limnocalanus grimaldi															c	c		
L. johanseni	28	81			c	1	+		96	38		+	14	17	c	c	1	15
Pseudocalanus minutus			1	+														
Tortanus discaudatus			c	c														
Harpacticoids			+	1	+	+	5	72	+	+								
Daphnia	2	6			99	97	+		c	37	+	85	80				40	57
Podon			+	+			1	12										
Evadne			+				+	+										
Clam shrimp	2	1			+				3	25								
Fairy shrimp (Anostraca)	c																	
Ostracods		+		+		+	+				+							+
Neomysis (juvenile)								+										
Sagitta			+															
Fish larvae (total found)				3				7										
Rotifer												9						

the University of Washington from collections made near the outlet on Aug. 22, 1959. These are the only known locality records for the American coast. Elsewhere the species occurs on the Asian coast.

The other neritic species encountered are quite common in small numbers on the Alaskan coast to Point Barrow and in diminishing numbers eastward (Johnson, 1953, 1956).

In lagoon no. 4 south, the plankton was sparse and *Acartia bifilosa* was the most numerous copepod in the surface water on Aug. 6, but an unidentified harpacticoid was the dominant form at the bottom on Aug. 13. It is probably a benthic species since the net contained much bottom debris. Intermingled in the plankton on both dates were the neritic cladocerans, *Podon* and *Evadne*, as the chief evidence of marine invasion.

The plankton fauna of all of the remaining lagoons in the numbered series was characteristically fresh-water. However, there was still a strange marine affinity evidenced by the presence of *Limnocalanus grimaldi* and *L. johanseni*. The former species was common in lagoon no. 1 north, and the latter in all other lagoons with the exception of no. 2 south. The species of this copepod genus have long been the subject of much speculation with respect to their geographic distribution and affinities to the sea. One species, *L. macrurus*, commonly occurs in deep fresh-water lakes, and is generally believed to be a marine relict of glacial times. *L. grimaldi* is an Arctic marine and brackish-water form occurring along the Arctic coast of the U.S.S.R. and is also considered to be a relict of Arctic fauna when found in such widely different isolated localities as the Caspian Sea, the Gulf of Bothnia, and the Baltic Sea. Aside from its present occurrence in lagoon no. 1 north, it has been reported from the Alaskan coast on two previous occasions, once from a collection taken about 100 yd. from the shore at Collinson Point (Willey, 1920), and once at a series of nine offshore stations in the same region, and off the mouth of the Colville River (Johnson, 1956). The present discovery is therefore of special interest in extending the known range of the species on the Alaskan coast, and in recording its occurrence in virtually fresh water, together with *Eurytemora foveola* n. sp. that apparently thrives best at very low salinities.

Less is known about the distribution of *Limnocalanus johanseni*. It was originally described by Marsh (1920) from a fresh-water pond at Collinson Point, just inland from, but not connected with, the shore where Willey recorded *L. grimaldi*. Subsequently, Comita and Edmondson (1953) reported it from Imikpuk Lake, a fresh-water lake near Point Barrow. In the present survey it was a conspicuous element ranging from small to dominant numbers in all lagoons except no. 2 south, the one which most nearly approaches marine conditions. In lagoon no. 5 south, it was extremely abundant, and although a considerable number of early copepodid stages occurred mingled with adults no nauplii were observed. This agrees in general with the observations of Comita (1956) in a more extensive analysis which indicated that the eggs of this species in Imikpuk Lake hatched early in spring, and only copepodid stages are to be found in late July and August. His data show no nauplii after Jul. 31 and the first appearance of adults (copepodid stage VI) was on Aug. 10. In the present collections from lagoon no. 5, adults already outnumbered the other stages on Aug. 6, when the first sampling was done. Comita concluded that *L. johanseni* in Imikpuk Lake produces only one generation a year and that the species winters over in the egg stage. This agrees with the known life cycle of another fresh-water species, *L. macrurus*, discussed by Gurney (1931). Another similarity between the populations of Imikpuk Lake and lagoon no. 5 south was the presence of at least two size groups. This bimodality was not so pronounced in the males as in the females, but some tendency is shown (Fig. 2). The present analysis of the population applies only to the standing crop at the time of sampling, and hence further comparisons cannot be made other than to note that the large-size group was the most abundant. But it cannot be said whether they were produced before or after the small-size group.

TAXONOMIC NOTES

The following observations can be made regarding a few of the species encountered.

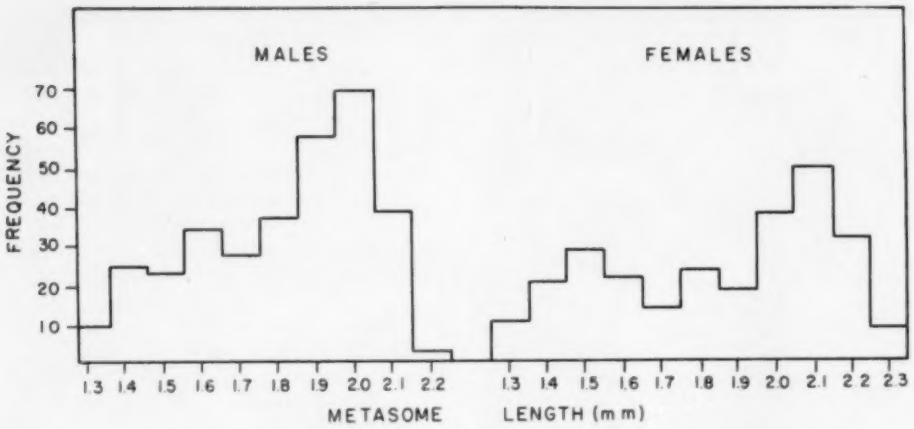


FIG. 2. Length frequency histogram for *Limnocalanus johanseni* adult (copepodid VI) population.

Limnocalanus grimaldi (de Guerne)

A total of 25 specimens was taken in lagoon no. 1 north, mostly near the bottom at a depth of only 3 m. Specimens were compared directly with *L. grimaldi* taken in 1950 in the Beaufort Sea at various stations offshore near Collinson Point and the Colville River. The fresh-water species *L. macrurus* Sars has not been seen for comparison. The Beaufort Sea specimens which were re-examined at this time agree well with the descriptions given in the literature for *L. grimaldi*. The head is not in the least vaulted as occurs in various degrees in *L. macrurus*, and there is only a slight cervical depression (Sars, 1897: pl. 4, figs. 2, 3, 17). The structure of the fifth feet also agrees. The first antennae of the female reach beyond the anterior margin of the anal segment. In the male there are five distinct segments in the distal end of the right antenna beyond the geniculation. The deviations from descriptions of *grimaldi* are mainly in the posterior margins of the fifth thoracic segment. These were smoothly rounded in some cases, but many specimens had the characteristic triangular or spine-like point, and this was sometimes present only on one side. The caudal rami were about eight times as long as broad and were slightly longer in relation to the urosome than given by Sars.

The specimens collected in lagoon no. 1 north are here also considered to be *L. grimaldi*, since they agree in nearly all respects with the Beaufort Sea material. The posterior margin of the fifth thoracic segment was acutely pointed in most specimens, but a few occurred with smoothly rounded margins (a characteristic of *L. macrurus*); there were, however, only four distinct segments in the distal end of the male right antenna beyond the geniculation. This is also a characteristic of *L. macrurus*, although Marsh (1933) states that in exceptional cases there may be five segments. The lagoon specimens were slightly smaller than those from the Beaufort Sea, namely 2.6 to 2.7 mm. as opposed to 2.9 to 3.3 mm. for females.

Since the condition of the fifth thoracic segment is obviously an unreliable character, one is left to choose between the relative specific value of the outline of the head, and the segmentation of the distal end of the male first antennae. Both of these are variable for *L. macrurus*. The habitat presented by lagoon no. 1 north is probably an important consideration, for although it was virtually fresh at the time and place of sampling, it is shallow and so near the sea that it may be reached by very high storm waves. This environmental situation may constitute an interesting natural experiment in which a landlocked population of *L. grimaldi*

has assumed some characteristics of its freshwater counterpart, particularly in the fusion of two of the segments in the distal portion of the male right antenna.

Limnocalanus johanseni Marsh

A comparison of specimens of this species from the lagoons and from collections I made in Imikpuk Lake in 1957 shows only small variations in structure. Mention should be made, however, of some features that are not included in the original description. It was noted that in many specimens the fifth thoracic segment may be smoothly rounded or with only slightly angular outline. Marsh states that this segment is rounded on the sides, and each side is armed with a small spine which may be either sharp or blunt. Apparently inadvertently omitted from Marsh's drawings is a long, heavy seta that occurs on the inner anterior distal angle of the second basis of the first feet.

Centropages abdominalis Sato 1913

Centropages mcmurrichi Willey 1920

Willey (1920) was apparently unaware of Sato's (1913) publication, and described this species as new under the name *C. mcmurrichi* n. sp. His description is without figures, but he considered the species to be identical with a copepod reported and figured by McMurrich (1916), with some reservations, as *C. hamatus* Lilljeborg. Examination of Alaskan material and reference to McMurrich's figures, and to those of Sato (photostatic copies of which are at hand through the courtesy of Dr. Takasi Tokioka and Isamu Yamazi of the Seto Marine Biological Laboratory), and of Mori (1937) leaves little doubt that these species are identical.

Eurytemora pacifica Sato 1913

Eurytemora johanseni Willey 1920

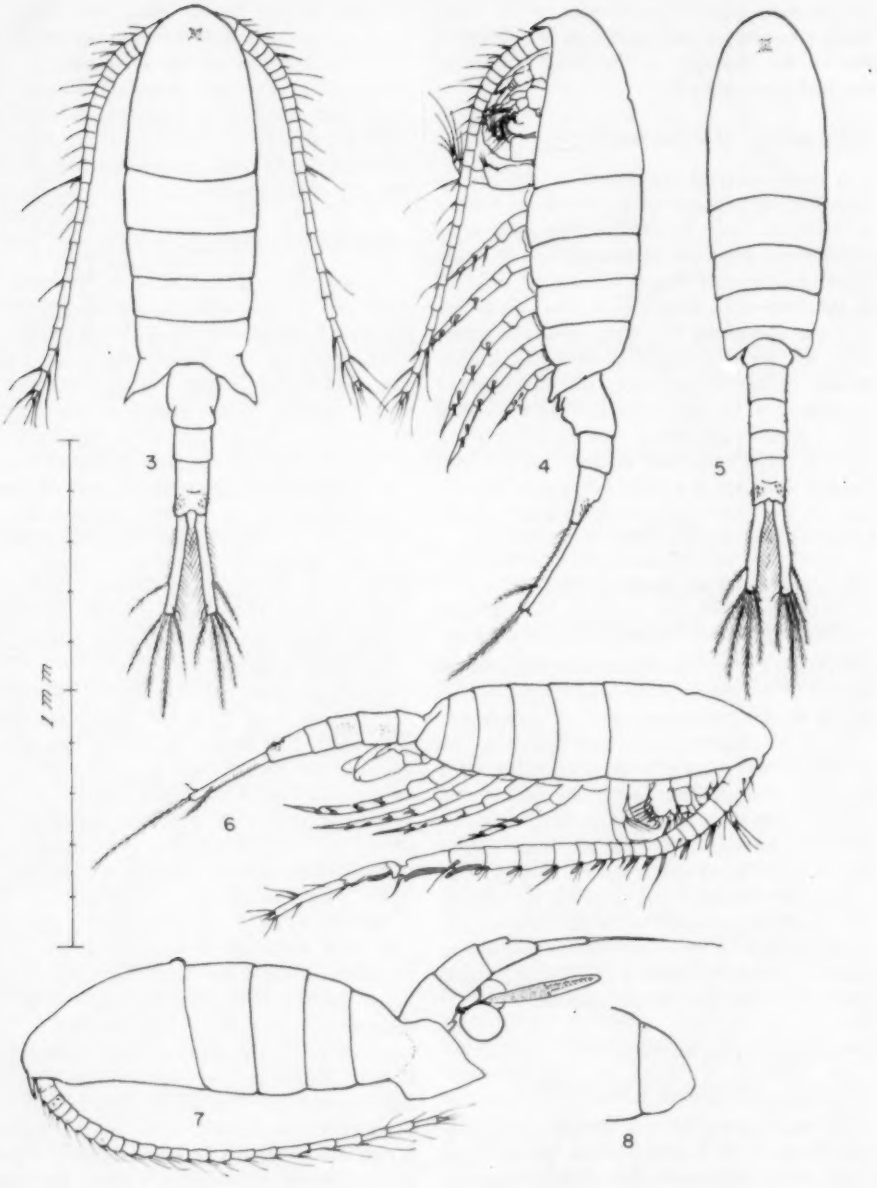
This is a clearly defined species, principally on the basis of the fifth feet in the female (Figs. 7–10). In the female, the fifth thoracic segment is provided with broad triangular wings, but breeding females were also found with this segment smoothly rounded (Fig. 8). The hyaline wing apparently may be shed or fails to develop. In the present study both males and females were found in the same catches. Willey (1920) described the species under the name *E. johanseni* n. sp. Sato described only the adult male, but his figures agree especially with Willey's figures 11 and 12 of the fifth feet. Smirnov (1931) first pointed out the probable identity of the species.

Eurytemora foveola n. sp.

TYPES: Holotype, male, U. S. National Museum no. 105996; allotype, female, USNM no. 105997. Type locality, lagoon no. 6 south.

In lagoon no. 6 south and nos. 1 and 2 north the dominant copepod was this hitherto unknown species. It was present in these lagoons in vast numbers and despite its small size constituted 90 per cent or more of the biomass in the samples from lagoon no. 6 south and no. 1 north where it was actively reproducing and many females were found carrying eggs and spermatophores. In lagoon no. 2 north it was greatly surpassed in mass by the larger cladoceran *Daphnia*. It is closely allied to *Eurytemora gracilis*, both sexes of which were described by Sars (1898) from the lower Yana (Jana) River and, judging from Sars' figures and description, the females may be nearly indistinguishable. The chief differences separating the present species from that of Sars' are structural details in the fifth feet of the males. In view of these small but apparently persistent differences, as shown by examination of a great many specimens, it seems best to designate it a new species rather than a variety of *E. gracilis*.

FEMALE (Figs. 3, 4): Length 1.15–1.25 mm. The body is slender in both dorsal and lateral aspects with about the following linear proportions: metasome (anterior division) 67, genital segment 11, first abdominal segment 6, anal segment 11, caudal rami 17. The metasome is slightly widest in the region of the first pedigerous segment. There is a slight cephalic depression, but no medial knob on the posterodorsal margin of the cephalic segment. (In *E. gracilis* the greatest width appears to extend somewhat farther forward according to Sars' pl. 8, fig. 8; and in his fig. 9, the lateral profile also differs in that his species is relatively thicker through the midbody and the cephalic



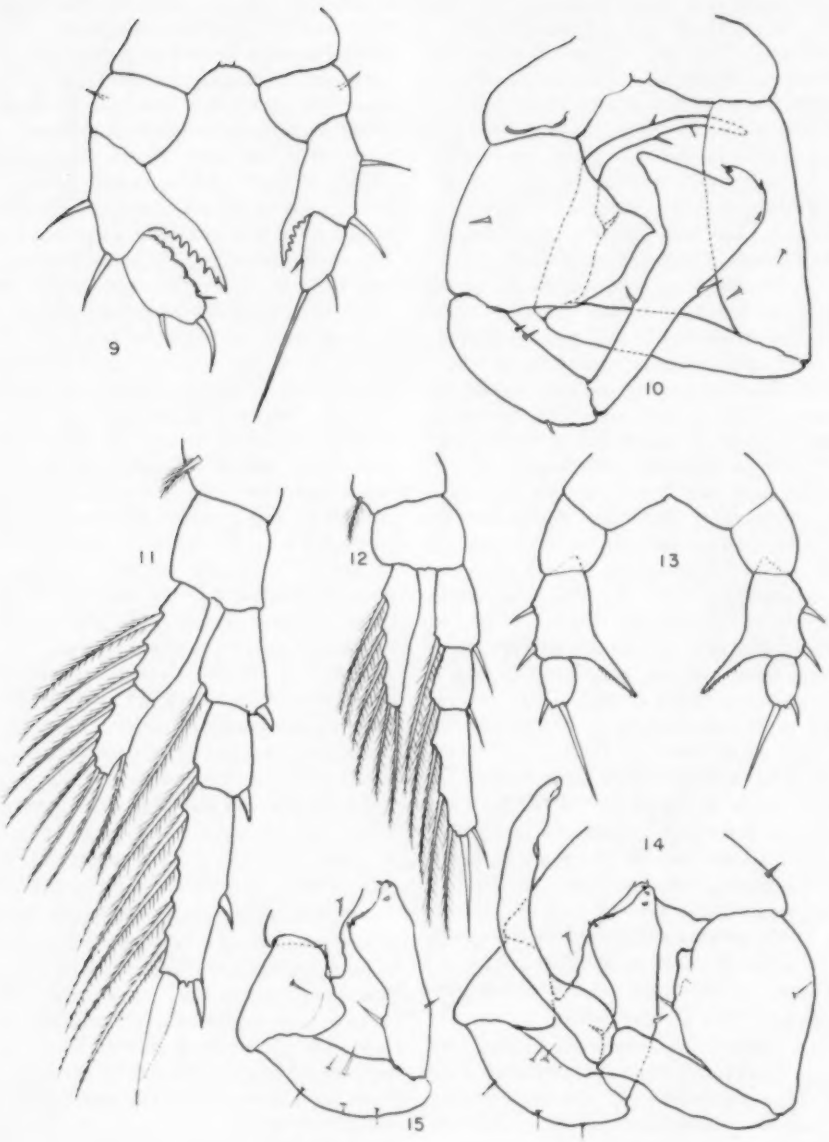
FIGS. 3–6. *Eurytemora foveola* n. sp. 3, Female, dorsal; 4, female, lateral; 5, male, dorsal; 6, male, lateral.

FIGS. 7–8. *Eurytemora pacifica*. 7, Female, lateral with eggs and spermatophore; 8, female, lateral outline of fifth thoracic segment occurring in some adults.

segment is slightly raised dorsally at the hind edge.) The fifth thoracic segment is extended into laterally projected "wings" that vary considerably in length and hyalinity. Many adult specimens were observed in which the left wing was only slightly developed, although the right wing was always well developed. The first antennae reach to, or slightly beyond, the fifth thoracic segment. The genital segment is nearly symmetrical and only slightly constricted laterally. It bears no lateral expansions but in lateral aspect has a rather conspicuous genital operculum. The anal segment is armed dorsolaterally with patches of fine spinules, best observed in aqueous media. (Sars states that in *E. gracilis* "the last caudal segment is perfectly smooth without any trace of the densely crowded spikes clothing the dorsal face of this segment in *T.* (*E.*) *hirundoides*.") The caudal rami are provided with fine "hairs" on both their inner and outer margins. The longest caudal setae are only slightly longer than the rami. The terminal spine of the exopod of the second, third, and fourth swimming feet (Fig. 11) is cultriform as in *E. gracilis*. The fifth feet (Fig. 13) are symmetrical as in *E. gracilis*, and the first exopod segment bears a heavy, slightly setose, unguiform process directed inward. There are two spines on the outer margin of this segment. The end segment is short and bears one long terminal spine and one short outer spine. The terminal spine of the exopod of the third and fourth feet is somewhat broadened in the middle and is shorter than the end segment. In the male this spine is longer and more slender. The genital operculum is rounded (Fig. 16) in contrast to the pointed operculum of the closely related species *E. affinis* as described and figured by Gurney (1931), and which he considers synonymous with *E. hirundoides*.

MALE (Figs. 5–6): Length 1.0–1.2 mm. The body is slender and nearly parallel-sided anteriorly but tapers posteriorly. The body proportions are about as follows: metasome 57, urosome (without caudal rami) 25, caudal rami 15. As in the female, the anal segment bears dorsal patches of tiny spinules. The caudal rami have fine "hairs" on the inner and outer margins. The right geniculated first antenna has 25 segments with moderately heavy spines on segments 8, 9, and 12. The fifth feet (Figs. 14, 15) are asymmetrical, uniramous, and each exopod consists of two segments. The specific characters separating the species from closely related forms are seen mainly in the basal segments and in the relative proportions of the segments of the rami. At the inner proximal margin of the second basipod of the right foot there is a well-defined rounded projection and associated smooth notchlike depression suggesting the specific name. The inner margin of the first basipod of the left foot projects downward, forming an irregular blunt process overlapping about one-third the length of the second basipod. The second basipod is broadened with an inward expanse forming a dull flange along the long axis of the segment. Sars' plate 8, figure 16, shows no trace of these three features for *E. gracilis*. Otherwise the exopod segments agree with that species which, however, appears to have a shorter first exopod segment on the left foot. The uncertain species described by Kiefer (1938) also differs in the absence of these characters and in the shape of the second basal segments of each foot. The second antennae and the mouth appendages of *E. foveola* are similar in the two sexes and appear to have no specific character except perhaps for the shape of the mandibular blade (Fig. 17). Few illustrations of other species are available with which to make comparisons, but the gap between the first and second tooth is considerably wider than that figured by Gurney (1931) for *E. affinis*, Sars (1903) for *E. velox*, and Wilson (1953) for *E. yukonensis* and *E. composita*.

It should be mentioned that a single damaged female specimen of a *Eurytemora* was collected by the Canadian Arctic Expedition offshore near Cape Thompson. Willey (1920) tentatively referred it to *E. gracilis*. It is not possible to conclude what species he dealt with but the proximity of the catch to the lagoons so richly populated by *E. foveola* makes it highly likely that it had been washed out from a nearby lagoon. Although there may be an intermittent present-day connection between the Yana River population and that in the Cape Thompson area, it must be a very tenuous one for a fresh- or brackish-water species, especially in view of the prevailing oceanic circulation northward through



FIGS. 9–10. *Eurytemora pacifica.* 9, Female, fifth feet; 10, male, fifth feet.

FIGS. 11–15. *Eurytemora foveola* n. sp. 11, Female, fourth foot; 12, female, first foot; 13, female, fifth feet; 14, male, fifth feet; 15, male, left fifth foot.

the Bering Strait and eastern Chukchi Sea. However, other studies indicate that plankton organisms may be transported across rather well-defined currents by eddy diffusion, and the prevailing currents along the Siberian coast might bring expatriates into the western portion of the Chukchi Sea. Brodskii (1950) does not include *E. gracilis* in his list of copepods of the Polar Basin.

Gurney (1931) has pointed out the specific variabilities that may occur in several species of *Eurytemora* living in different habitats in Europe. It remains to be shown to what extent *E. foveola* may also be morphologically variable in diverse environments. The great range of Alaskan lagoon and estuarian habitats and the seven or more species on the Alaskan coast should provide excellent material for such a study.

SALINITY RELATIONS

Although the data are too few to give more than a glimpse into the salinity tolerances observed for the various copepod species identified, still it is worthwhile to record such analyses as can be made from this area. Figure 19 appears to divide the copepods encountered into three groups with respect to salinity range and preference. (1) *Acartia bifilosa* and *A. clausi* occurred over nearly the whole range encountered but not below 0.83 ‰ at which value only relatively few specimens were found, especially *A. clausi*. The former was the dominant copepod in the two lagoons having highest salinities 6.42 to 15.96 ‰. (2) *Cyclops* spp., *Eurytemora canadensis*, and *Limnocalanus johanseni* ranged from 0.16 to about 7 ‰ but appeared to thrive best at 0.73 to 0.83 ‰. *Eurytemora foveola* n. sp. probably belongs to this group but stands somewhat alone in occurring only in ranges from 0.18 to 0.73 ‰ at which salinities it was dominant. *Limnocalanus grimaldi*, in this unique situation, occurred also at only a very low salinity, but elsewhere in the arctic it has a strong affinity for the sea. (3) The final group, into which *Acartia bifilosa* and *A. clausi* extended, are the characteristically marine forms occurring in lagoon no. 2 south with salinities of 14.31 to 15.96 ‰. Only in the more saline lagoons, nos. 2 and 4 south, was there any appreciable range in salinity from top to bottom. These two lagoons are also probably the ones most readily invaded by marine forms, but the influx of fresh water appears also to be quite high in these lagoons. Hence the communities are probably more or less transitory and fluctuate with repeated recolonizations.

Whittaker and Fairbanks (1958) have studied the occurrence of various nonmarine copepods in inland lakes and ponds of different salt content. The salinities and fauna they dealt with are of course not directly comparable with those of coastal lagoons, since the ratio of salts differ and their more saline species have different taxonomic relationships. But it is interesting to note that the transition between saline and fresh-water communities in their study was "somewhere between 425 and 875 ppm" for most bodies of water. If a comparison is justified it must be with the fresh-water fauna of the lagoons, then lagoons nos. 1, 3, 5, and 6 south and 1 and 2 north could be expected to foster truly fresh-water species and the occurrence of *Eurytemora canadensis* and *Limnocal-*

FIGS. 16–18. *Eurytemora foveola* n. sp. 16, Female, genital field and operculum, ventral; 17, male, mandibular blade; 18, male, labrum.

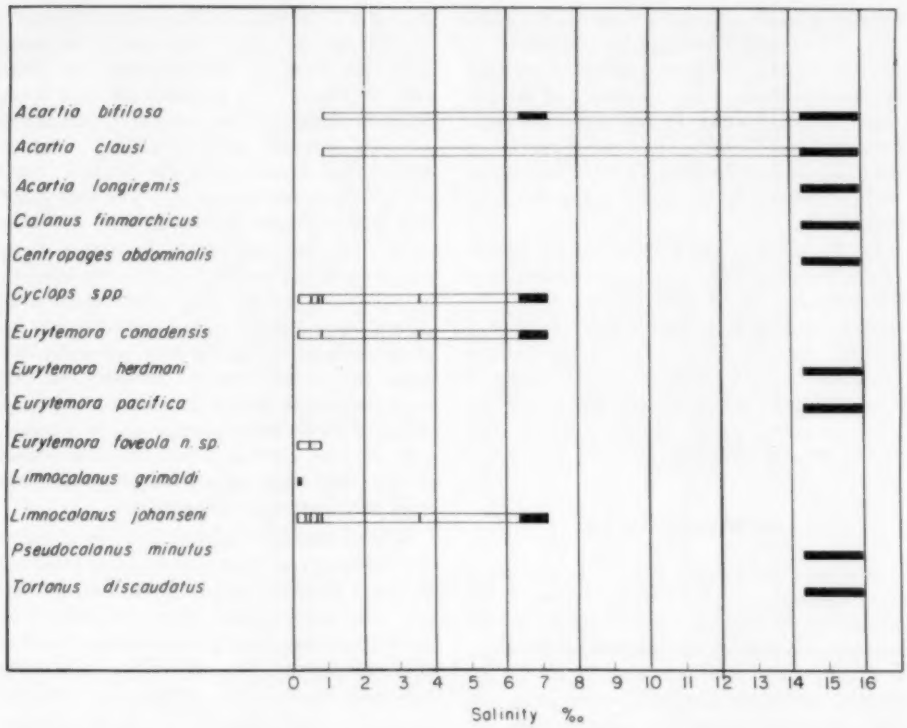


FIG. 19. Total salinity ranges over which certain copepod species occurred in nine coastal lagoons near Cape Thompson, Alaska, 1959. Cross bars denote salinity at stations of sampling.

anus johanseni in most of these and in lagoons nos. 4 and 7 south would mark them as quite euryhaline but with preferences for the lower salinities.

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Revision of the Genus *Pandanus* Stickman, Part 3
A New Species from Oeno Island, Tuamotu Archipelago

HAROLD ST. JOHN[1]

PREVIOUS PARTS of this revision of *Pandanus* have appeared in *Pacific Science*. A single species is here published in order that its name may be available for use in another projected publication.

PANDANACEAE (SECTION *Pandanus*)

Pandanus feruliferus sp. nov.
Fig. 11

DIAGNOSIS HOLOTYPI: Arbor 10 m. altus 30 cm. diam. corona rotundata, foliis longioribus 92 × 5.4 cm. longe diminuentibus in basi paene latioribus subcoriaceis, nervo medialein parte tertia infera inerme in media cum dentibus acicularibus luteis adpressis 1.5–2 mm. longis 14–38 mm. distantibus in parte tertia ultima dentibus nigris 1 mm. longis 1.5–4 mm. distantibus, marginibus in basi inermibus sed in parte quarta infero cum dentibus subulatis luteis adpressis 2–2.5 mm. longis 2–7 mm. distantibus in parte media simulantibus sed nigris in parte quarta ultima ad eos marginis simulanties, syncarpio terminale, phalangibus 6–6.2 cm. longis 2.3–3.7 cm. lotis 2.1–3 cm. crassis oblanceo-ellipsoideis paene compressis epiderme

[1] B. P. Bishop Museum, Honolulu 17, Hawaii, U.S.A. Manuscript received December 12, 1959.

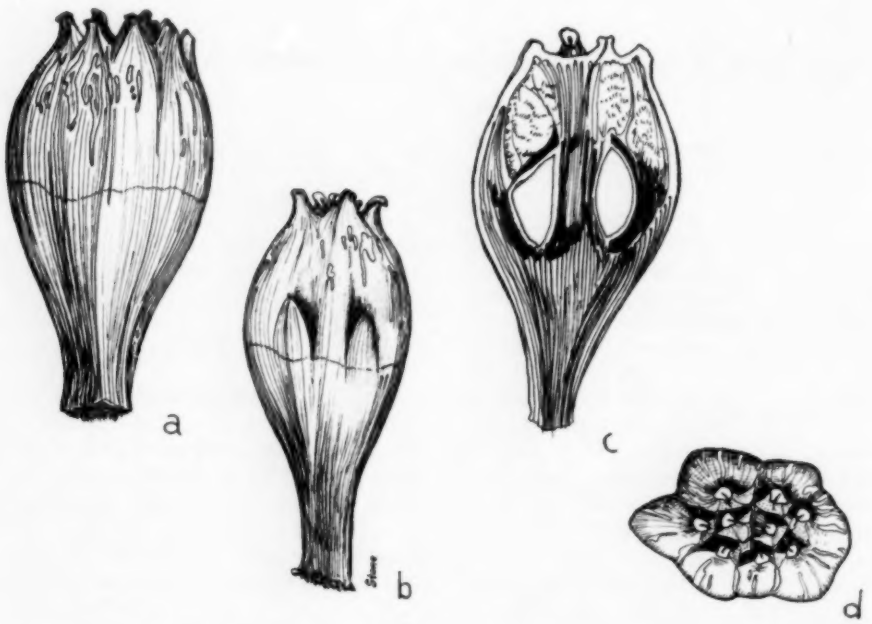
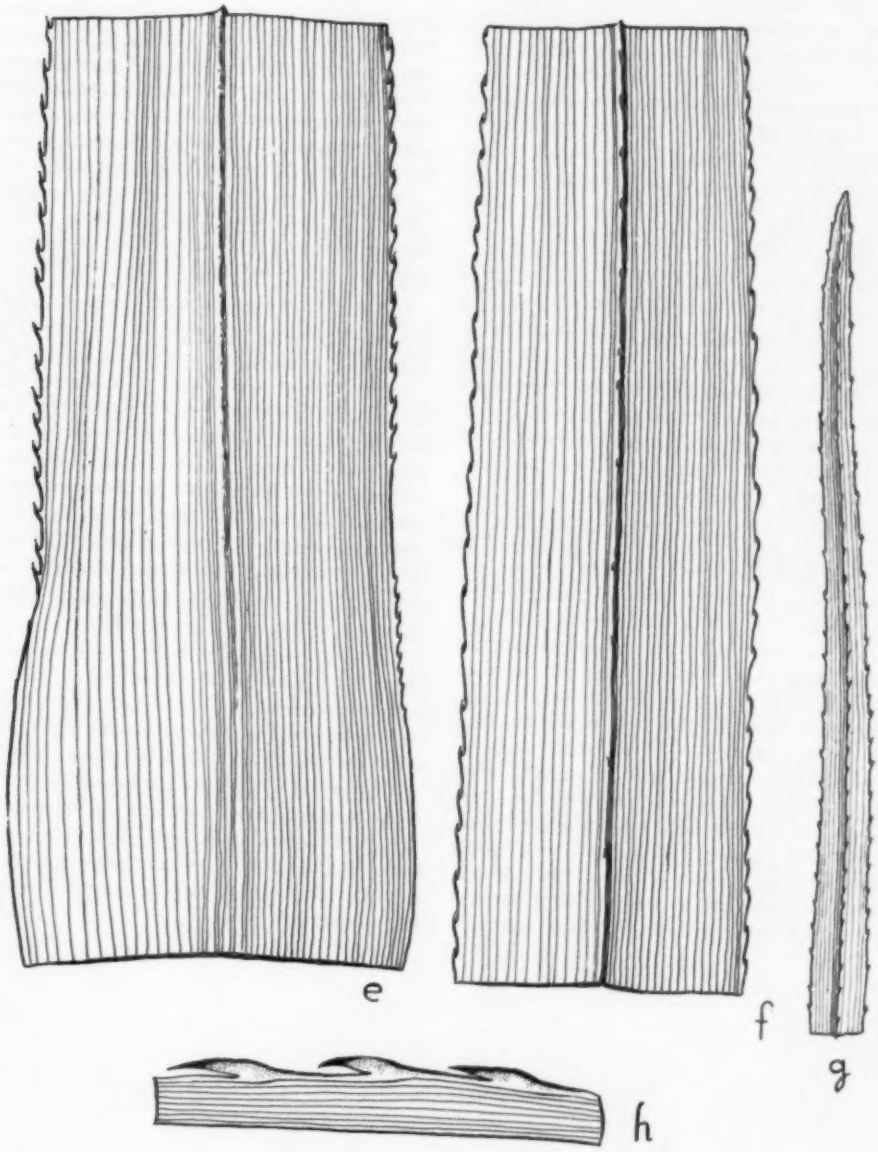


FIG. 11. *a, b*, Phalange, lateral view, × 1; *c*, phalange, longitudinal median section, × 1; *d*, phalange, apical view, × 1; *e*, leaf base, lower side, × 1; *f*, leaf middle, lower side, × 1; *g*, leaf tip, lower side, × 1; *h*, marginal teeth of leaf near base, × 4.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in sicco brunneo lucido cum 5–8 angulis eprominentibus lateribus laevibus lucidis subplanosis sinibus lateribus subcausis dimidia supera libera apice convexo et 7–24 mm. lato, apicibus liberis carpelorum anguste conicis eis centralibus erectis sed eis marginis extus curvatis sinibus centralibus 3–5 mm. profundis, 40% phalangiorum cum 1–3 carpelis lateralibus parvis abortivis et 40% minoribus, carpellis 5–11; stigmatibus apicalibus 2–3 mm. longis suborbicularibus vel ovatis fissis centripetalibus in 45° obliquis, mesocarpio apicale fibroso et cavernoso, mesocarpio basale fibroso et carnoso, endocarpio mediale osseoso obscure mahogani-brunneo gracile 1–2 mm. crasso, seminibus 12–16 mm. longis 5–7 mm. latis oblique ellipsoideis.

DIAGNOSIS OF HOLOTYPE: Tree 10 m. tall, 30 cm. in diameter, round-topped; longer leaves 92 cm. long, 5.4 cm. wide, ligulate, long tapering to an apparently acute apex, at basal attachment only slightly broadened, subcoriaceous, the midrib unarmed on the lower third, near the middle with ascending yellowish acicular appressed teeth 1.5–2 mm. long, 14–38 mm. apart, on the upper third the teeth 1 mm. long, 1.5–4 mm. apart, black; the margins at base unarmed, near the lower quarter the teeth 2–2.5 mm. long, 2–7 mm. apart, appressed subulate yellowish; those near the middle similar but black; those of the upper quarter like those on the adjacent margins; heads terminal, size and shape not recorded; phalanges 6–6.2 cm. long, 2.3–3.7 cm. wide, 2.1–3 cm. thick, oblance-ellipsoid, a little compressed, the surface (when dried) brown, smooth, shining, with 5–8 slight angles, the sides shining, smooth, nearly plane, the sutures between the lateral carpels mostly invisible, only a few of them with distinct furrows about half as long as the phalange, upper half free and marked with numerous longitudinal light-colored cracks, the sides curving upward like an ellipse, the apex convex and 7–24 mm. wide, the free carpel apices narrowly conic, the central ones erect, the marginal ones curved, diverging, the central sinuses 3–5 mm. deep; of the phalanges 2/5 show 1–3 small abortive lateral carpels about 2/3 as long as the fertile ones; carpels 5–11; stigmas apical, 2–3 mm. long, suborbicular to ovate, creased, centripetal, oblique, at about 45° facing the center; apical mesocarp fibrous and cavernous; basal mesocarp fibrous and fleshy; endocarp median, bony, dark mahogany brown, forming a thin coating only 1–2 mm. thick; seed 12–16 mm. long, 5–7 mm. wide, oblique ellipsoid.

HOLOTYPUS: Oeno Island, Tuamotu Archipelago, forest on coral sands, 3 m. alt., June 23, 1934, *H. St. John & F. R. Fosberg 15,197* (BISH).

In the Bishop Museum there is another collection from Oeno, 1922, *E. H. Quayle 410*. The leaf has larger, coarser, more widely spaced, marginal teeth. It might be a leaf from a vigorous seedling of this species, but the collection lacks fruit, so it will be left undetermined.

A similar plant is *P. odoratissimus* L. *f.* var. *oahuensis* Martelli from Hawaii, but this has phalanges 6.5 cm. long; and the carpel apices inflexed and low, broad pyramidal.

More similar is *P. Mei* F. Br. which has phalanges 7 cm. long, 2.5 cm. wide, the six carpels with apices convex; stigmas 4 mm. in diameter, reniform, horizontal; endocarp walls 2.5–5 mm. thick. This occurs on Hivaoa, Marquesas Islands.

The specific epithet is coined from the Latin, *ferula*, a splint; *fero*, to bear. It is formed in analogy to the splints or vestigial digit bones in a horse's leg, since the *Pandanus* phalanges often bear abortive marginal carpels, suggestive of the splint bones of a horse.

Revision of the Genus *Pandanus* Stickman, Part 4
Disposition of Some Later Homonyms

HAROLD ST. JOHN[1]

Pandanus glauciferus St. John, nom. nov.

P. glauciphyllus C. B. Robinson, Torrey Bot. Cl. Bull. 35: 64, 1908, non *P. glaucophyllus* Ridl., Asiat. Soc. Str. Br. J. 41: 50, 1904.

Under the 1956 International Code, Rec. 73G and Art. 73 Note 2, the epithet *glauciphyllus*, differing only in the connecting vowel, and *i* being an incorrect one, is an orthographic error. The epithet *glauciphyllus* must be treated as a later homonym and under Art. 64(2) must be rejected. Hence, a new name for it is provided.

Pandanus compressus Martelli, Webbia 1: 363, 1905; 4(1): table 10, figs. 14–15, 1913.

P. tetrodon Balf. *f.* ex Kanehira, Bot. Mag. Tokyo 52: 236–239, fig. 70, 1938, avowedly by (Gaud.) Balf. *f.*, based on *Barrotia tetrodon* Gaud., non *P. tetrodon* Ridl., R. Asiat. Soc. Str. Br. J. 68: 13–14, 1915.

The genus *Barrotia* Gaud. was published in 1841 in the botanical atlas of the voyage of "La Bonite." The new genus was not given a description, and since it contained three species, the genus and its species are invalid and these cannot be adopted or transferred. Balfour in 1878 printed the combination *P. tetrodon* (Gaud.) Balf. *f.*, but did not accept it himself. Hence, *P. tetrodon* Balf. *f.* ex Kanehira dates only from 1938 and is a later homonym of *P. tetrodon* Ridl. Kanehira attempted to solve the problem by renaming *P. tetrodon* Ridl. as *P. singaporensis* Kaneh. (1938), but this action was illegal, and Ridley's species stands.

For *P. tetrodon* Balf. *f.* ex Kanehira there is an available, legitimate name: *P. compressus* Martelli, based on a collection from the Solomon Islands.

[1] Faculté des Sciences, Université de Saigon, Vietnam. Manuscript received April 1, 1960.

Revision of the Genus *Pandanus* Stickman, Part 5
Pandanus of the Maldive Islands and the Seychelles Islands, Indian Ocean

HAROLD ST. JOHN[1]

THE MALDIVE ISLANDS form a western fringe of atolls off the coast of India and Ceylon. Their flora was summarized by J. C. Willis and J. S. Gardiner (1901), but *Pandanus* has not received particular attention. They recorded *Pandanus* on many of the atolls, and described their utilization for mats, pillows, sails, and for food. Three species were listed: *P. odoratissimus* L. *f.*, *P. Leram* Jones *ex* Fontana with the doubtful synonym (? *P. Hornei* Balf. *f.*), and *P.* sp. indet. The present writer considers the first to be a misidentification with the Ceylonese species; the second, *P. Leram,* is confined to the Andaman and Nicobar Islands, and the Maldive plant is doubtless the new *P. Fosbergii* St. John, and the third remains undetermined. Four additional species of the affinity of *P. odoratissimus* are here described.

Dr. F. R. Fosberg in 1956 observed and collected *Pandanus* on several of the islands. He identified (1957: 11) them as *P. odoratissimus.* His no. 36,916 is here described as *P. maldivecus* St. John; and his no. 36,899 as *P. Fosbergii* St. John.

Dr. W. D. Hartman was a member of the Yale University 1957 Expedition to the Indian Ocean. From his excellent collections there are here described several new species.

Hartman also visited the Chagos Archipelago, but on his brief land excursions he found no *Pandanus.*

SEYCHELLES ISLANDS

The flora of these islands is well known and was well presented by Baker (1877). From the islands we know *P. Balfourii* Martelli, *P. Hornei* Bory, *P. multispicatus* Balf. *f.*, and *P. sechellarum* Balf. *f.* Of these, Hartman in 1957 collected all but the third, and his complete specimens allowed supplements to the previously published descriptions.

For Aldabra Atoll, J. C. F. Fryer (1912: 402) recorded *P. Vandermeeschii* Balf. *f.* in Baker, a species now considered endemic to Mauritius. The Aldabra specimens are in need of further revision, and the writer has not seen them as yet.

Pandanus OF THE MALDIVE ISLANDS

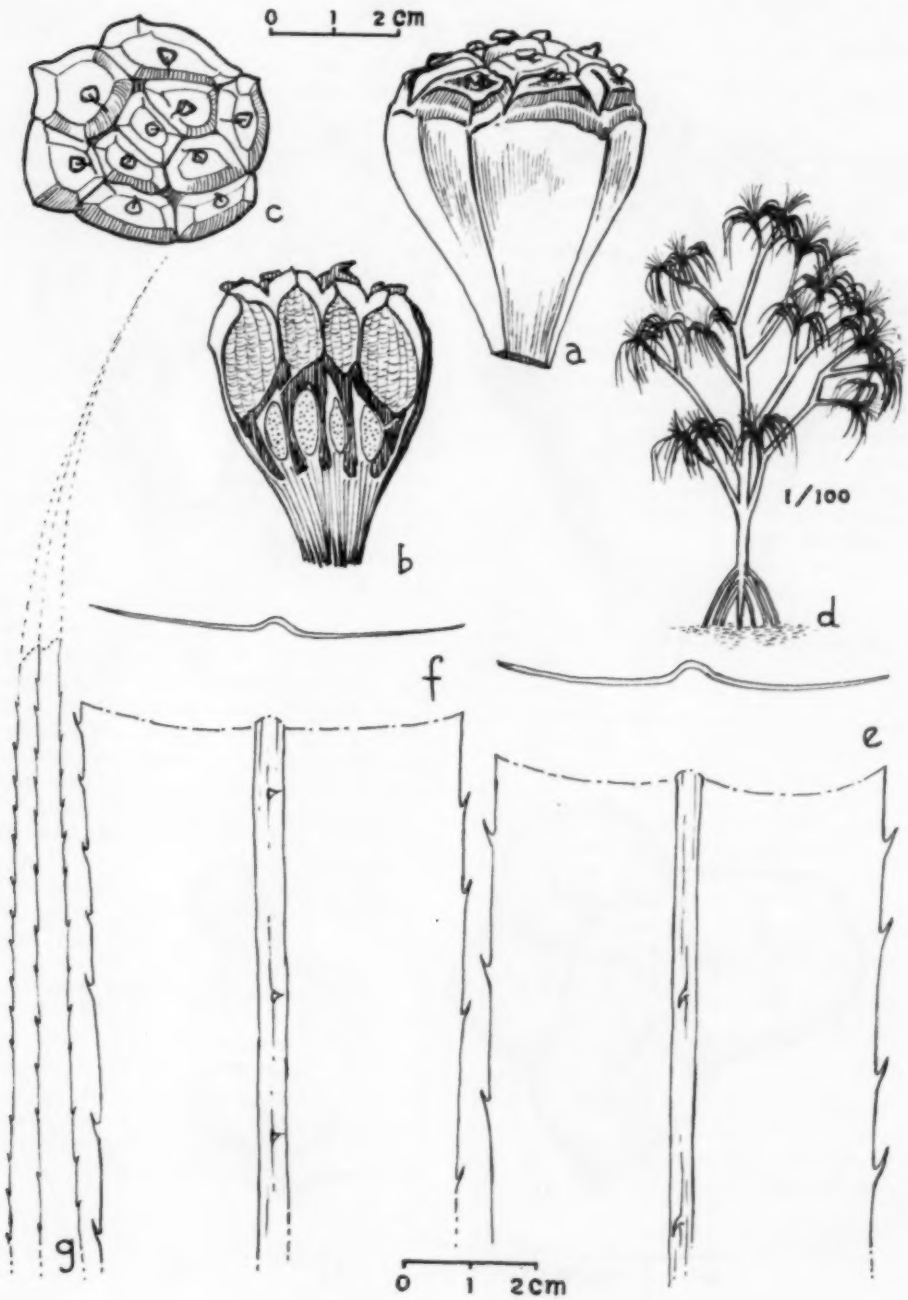
Pandanus adduensis sp. nov. (sect. *Pandanus*) Fig. 12

NOM. VERN.: "karikayo."

DIAGNOSIS HOLOTYPI: Arbor 6–7 m. alta, corona late ovoidea, radicibus fulturosis evidentibus, foliis 150 cm. longis 6.3 cm. latis firme subcoriaceis ligulatis apice gradatim longe acuminatis apice ultimo non viso ad basem M-formatis, marginibus in regione basali cum aculeis 3–4 mm. longis 12–22 mm. distantibus adscendentibus forte subulatis cum basibus incrassatis et apicibus obscure brunneis midnervio proximo infra cum aculeis 2.5–3 mm. longis 11–30 mm. distantibus reflexis crasse subulatis cum basibus incrassatis, in regione mediali marginibus cum aculeis 2–3 mm. longis 8–22 mm. distantibus subulatis in 30° adscendentibus, midnervio proximo infra inermi; in regione apicali aculeis 0.4–0.6 mm. longis crasse subulatis in 45° adscendentibus eis marginalium 3–5 mm. distantibus illis midnervi 5–10 mm. distantibus adscendentibus, phalangibus 4.5–4.9 cm. longis 3.4–4.1 cm. latis 3–3.7 cm. crassis obovoideis basi cuneata apice valde convexo, parte ¼ supera libera lateribus laevibus lucidis in sicco brunneis fere planatis anguste

[1] B. P. Bishop Museum, Honolulu 17, Hawaii, U.S.A. Manuscript received May 20, 1960.

FIG. 12. *Pandanus adduensis,* from the holotype. *a,* Phalange, lateral view, × 1; *b,* phalange, longitudinal section, × 1; *c,* phalange, apical view, × 1; *d,* tree, × 1/100; *e,* leaf base, lower side, × 1; *f,* leaf middle, lower side, × 1; *g,* leaf apex, lower side, × 1.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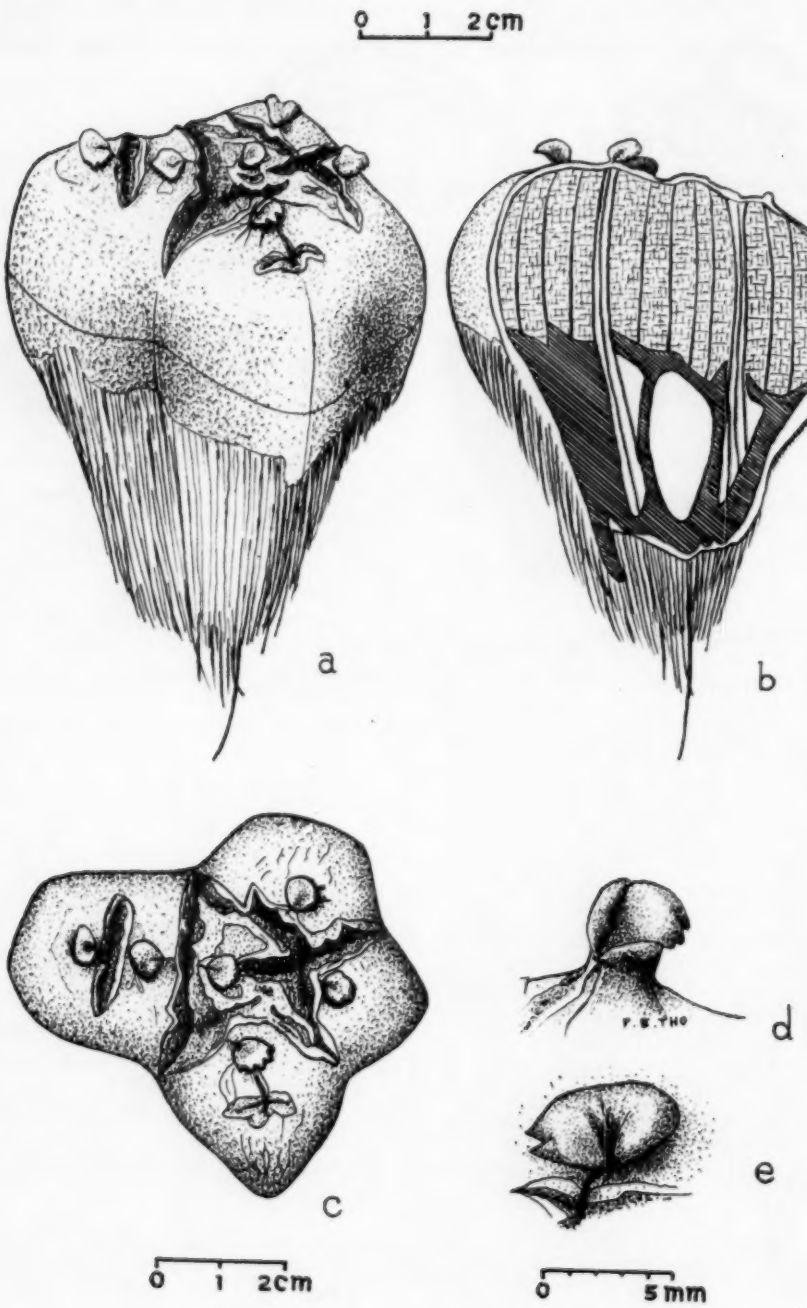
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6–7-angulosis, suturis lateralibus nullis, sinibus apicalibus centralibus 3–4 mm. profundis V-formatis (phalangiis geminatis 5–5.5 cm. latis et carpellis 18–22), carpellis 9–13, apicibus humiliter pyramidalibus eis centralibus valde oblatis illis marginalibus late distali truncatis et etiam concavis, stigmatibus 2.5–4 mm. longis cordatis vel irregulariter ellipticis oblique inclinatis centripetalibus, sutura proximali ⅓–½ distancia ad fundum extenta, endocarpio paene submediali osseoso obscure brunneo marginibus lateralibus 2 mm. crassis, seminibus 8–10 mm. longis 3.5–5 mm. diametro oblique ellipsoideis, mesocarpio apicali in quaque carpella cavernoso cum fibris longitudinalibus et membranis medullosis, mesocarpio basali fibroso.

DIAGNOSIS OF HOLOTYPE: Tree 6–7 m. tall; crown broad ovoid; prop roots present; leaves 150 cm. long, 6.3 cm. wide, firm subcoriaceous, M-shaped in cross-section, ligulate, the apex gradually long acuminate, but the tip not seen, the margins near the base with prickles 3–4 mm. long, 12–22 mm. apart, stout subulate, broad based, ascending, dark brown tipped; the nearby midrib below with prickles 2.5–3 mm. long, 11–30 mm. apart, reflexed, stout subulate from an enlarged base; at the midsection the margins with prickles 2–3 mm. long, 8–22 mm. apart, subulate, ascending at 30°; the midrib unarmed; near the apex the margins and midrib below with ascending prickles 0.4–0.6 mm. long, stout subulate, ascending at 45°, those of the margin 3–5 mm. apart, but those of the midrib 5–10 mm. apart; phalanges 4.5–4.9 cm. long, 3.4–4.1 cm. wide, 3–3.7 cm. thick, obovoid with the base cuneate and the apex convex, upper ¼ free, the sides smooth, shining, brown when dry, almost plane, sharply 6–7-angled, lateral sutures none; central apical sinuses 3–4 mm. deep, V-shaped; (phalange twins 5–5.5 cm. wide and with 18–22 carpels); carpels 9–13; carpel apices low pyramidal, the central ones strongly oblate, the marginal ones broad truncate and even concave distally from the stigma; stigmas 2.5–4 mm. long, cordate or irregularly elliptic, oblique, centripetal; proximal suture running ⅓–½ way to valley bottom; endocarp slightly submedian, bony, dark brown, the lateral margins 2 mm. thick; seeds 8–10 mm. long, 3.5–5 mm. in diameter, obliquely ellipsoid; apical mesocarp in each carpel a cavity with longitudinal fibers and pithy partitions; basal mesocarp fibrous.

HOLOTYPUS: Maldive Islands: Addu Atoll, Hitadu Islet, near shore, common, Oct. 13, 1957, *W. D. Hartman 4* (Arn. Arb.).

DISCUSSION: *P. adduensis* is a member of the section *Pandanus*. In that section its close relative is an undescribed species from Papua, *St. John 26,234*, which has the phalange upper third free, the apex low convex; carpel apices rounded pyramidal, the outer ones with an oblique outer plane surface reaching only to the stigma; stigmas 1–2 mm. long, ellipsoid; bark with papillae developing ascending rootlets. *P. adduensis* has the phalange with the upper quarter free, its apex convex; carpel apices low pyramidal, the marginal ones broad truncate and even concave distally from the stigma; stigmas 2.5–4 mm. long, cordate or irregularly elliptic; and the bark lacking ascending rootlets.

The new epithet is made of *Addu*, the type locality; and *-ensis*, the Latin adjectival place ending.

Pandanus Fosbergii sp. nov. (sect. *Pandanus*)
Figs. 13–14

NOM. VERN.: "karikio."

DIAGNOSIS HOLOTYPI: Arbor 6–8 m. alta, foliis 3–4 ("ad saltem 4") m. longis 11–13 cm. latis firmis spongioso-coriaceis minime M-formatis in sectio ligulatis sed ad apicem constrictis in apice (acuto?), basi amplexicaule exarmatis per 10 cm. deinde marginibus grosse subulato-serratis serris 3.5–5 mm. longis 10–25 mm. distantibus in apice brunneis, midnervio infra cum serris simulantibus 3 mm. longis 15–30 mm. distantibus reflexis, in regione mediali marginibus cum serris 3–4 mm. longis 7–17 mm. distantibus grosse subulatis adpresse adscendentibus, midnervio infra salienti et cum dentis sumulantibus adscendentibus 4–8 cm. distantibus, proxima apice marginibus subulato-

FIG. 13. *Pandanus Fosbergii*, from holotype. *a*, Phalange, lateral view, × 1; *b*, phalange, longitudinal section, × 1; *c*, phalange, apical view, × 1; *d*, *e*, stigmas, oblique view, × 4.

serratis dentibus 1 mm. longis 1.5–3 mm. distantibus adscendentibus, midnervio cum serris simulantibus sed 3–13 mm. distantibus, pedunculo circa 30 cm. longo trigono folioso, bracteis longe subulato-acuminatis et cum spinis simulantibus, syncarpio "oblongo scilicet 3 dm. longo 1.5 dm. diametro," phalangibus 8.7 cm. longis 6.2 cm. latis 5.2 cm. crassis late cuneiformibus sed in sectio transversali trigono, apice subconvexo, parte ⅓ supera libera, sutures lateralibus nullis, lateribus laevibus gradatim convexis in sicco pallide brunneis obtuse 3–4-angulosis, sinibus centralibus apicalibus nullis suturis tantum lineis superficielibus tessellatis sed in post maturite cum rima lata, carpellis 6, apicibus subconvexis non protensis, stigmatibus 4–5 mm. longis suborbicularibus vel obreniformbus centripetalibus tota elevatis obliquis, sutura proximali plerumque ad suturam extenta, endocarpio mediali 3–4 cm. longo osseoso obscure brunneo superficie interiori lucida, marginibus lateralibus 2–3 mm. crassis, seminibus 2.2–2.4 cm. longis 11 mm. diametro anguste obovoideis, mesocarpio cum cavernis subdistinctis cum fibris et medulla firma persistenti, mesocarpio basali fibroso et carnoso et dicet esculenti.

DIAGNOSIS OF HOLOTYPE: Tree, up to 6–8 m. tall, large stemmed; leaves 3.4 "to at least 4" m. long, 11–13 cm. wide, firm, spongy coriaceous, slightly M-shaped in cross-section, ligulate, but near the apex narrowed to the (acute?) tip, the base amplexicaul, unarmed for about 10 cm., then the margins coarsely subulate serrate, the teeth 3.5–5 mm. long, 10–25 mm. apart, brown-tipped, the midrib below with similar teeth 3 mm. long, 15–30 mm. apart, reflexed; at the midsection the margins with the teeth 3–4 mm. long, 7–17 mm. apart, heavy subulate, appressed ascending, the midrib below salient and with similar, ascending teeth 4–8 cm. apart, near the apex the margin with teeth 1 mm. long, 1.5–3 mm. apart, subulate-serrations, the midrib below with similar teeth but these 3–13 mm. apart; peduncle about 30 cm. long, trigonous, leafy bracted, the bracts similarly spiny, and long subulate acuminate; syncarp "oblong, at least 3 dm. × 1.5 dm., but none seen mature"; phalange 8.7 cm. long, 6.2 cm. wide, 5.2 cm. thick, broad cuneiform, but trigonous in cross section, the apex low convex, upper ⅓ free, lateral sutures none, the sides smooth, gently convex, pale brown when dried; with 3–4 obtuse angles; apical central sinuses none, the suture lines merely superficial and tessellate; in post maturity a broad crack develops near each sutural region; carpels 6, their apices low convex, not projecting; stigmas 4–5 mm. long, suborbicular to obreniform, centripetal, wholly elevated and oblique; proximal crease running quite or nearly to the sinus line; endocarp median, 3–4 cm. long, bony, dark brown, the inner walls polished and shining, the lateral walls 2–3 mm. thick; seeds 2.2–2.4 cm. long, 11 mm. in diameter, narrowly obovoid; apical mesocarp of scarcely distinct caverns, with longitudinal fibers and a firm, persistent medullary tissue; basal mesocarp fibrous and fleshy, reported to be edible.

HOLOTYPUS: Maldive Islands: Malé Atoll, Kuda Bados Islet, occasional in coconut plantation, 1 m. alt., key picked up on ground nearby, April 1, 1956, *F. R. Fosberg* 36,899 (US).

DISCUSSION: *P. Fosbergii* is a member of the section *Pandanus*, but the structure of the apex of the phalange is bizarre for that section, and at a glance more closely resembles the section *Vinsonia*. This is due to the broad and obtuse apex of the phalange which is not lobed. The intercarpellary apical sinuses are superficial and are mere tessellate lines, though in postmaturity wide cracks appear at or near the sinus lines. Diagnostic of the section *Vinsonia* are the flush, horizontal stigmas. In *P. Fosbergii* the stigmas are of another sort. They are large (4–5 mm. long), strongly elevated, oblique and centripetal. Hence, under the present classification of the genus, the new species must be placed in the section *Pandanus*.

Though not a close relative, the most similar appearing species is *P. spiralis* R. Br. of Australia. This species has the phalanges 6 cm. long, the apex convex; carpels 9–20; stigmas 2–3 mm. long, hippocrepiform; seeds 4 mm. in diameter, very narrowly elliptic; and the apical mesocarp of separate caverns. *P. Fosbergii* has the phalanges 8.7 cm. long, the apex low convex; carpels 6; stigmas 4–5 mm. long, suborbicular; seeds 10 mm. in diameter, obovoid; and the apical mesocarp of confluent caverns.

This new species is named for its collector, Dr. F. Raymond Fosberg, of the U. S. Geological Survey.

This species seems to be the one recorded (and doubtless misdetermined) by J. C. Willis and J. S. Gardiner (1901: 104) as *P. Leram* Jones *ex* Fontana. That is a native of the distant Nicobar and Andaman Islands. It has massive phalanges roughly similar to those of the species here described, but the carpels are arranged in transverse, parallel lines, the stigmas are laterally directed, and the species belongs to a different section of the genus, *Hombronia*. They observed the plant, "a very large green stemmed *Pandanus*... reaching a height of over 50 feet, found in the Hulule, Turadu, Goifurfehendu, Limbo Kandu, &c. (Gardiner), and known as Karikeo (Keeva in Addu Atoll);..."

The tentative record of *P. Hornei* Balf. *f.* in Baker, by Willis and Gardiner (1901: 104), also seems to belong here.

Pandanus Hartmanii sp. nov. (sect. *Pandanus*) Fig. 15

DIAGNOSIS HOLOTYPI: Arbor 5–6 m. alta circa 12 cm. diametro, ramis horizontalibus deinde adscendentibus griseis laevibus, radicibus fulturosis multis sublaevibus 1–2 m. longis circa 4 cm. diametro et frequenter in 6–10 dm. ex terra divisis in radicellis pluribus, foliis 120 cm. longis 5.7 cm. latis firme subcoriaceis ligulatis in sectio late M-formatis longe attenuatis et in 10 cm. ex apice 2.5 mm. latis proxima basi marginibus cum spinis 3.5–5 mm. longis 8–18 mm. distantibus crassiter subulatis in 45° adscendentibus, midnervio cum spinis reflexis 2–3 mm. longis 10–12 mm. distantibus crassiter subulatis, in sectio mediali marginibus cum spinis 3.5–4.5 mm. longis 5–15 mm. distantibus adpressis crassiter subulatis, midnervio infra cum spinis 2–3 mm. longis 13–23 mm. distantibus adpressis et plerumque adscendentibus, proxima apice marginibus et midnervio infra cum spinis 0.6–0.8 mm. longis 7–14 mm. distantibus, aculeis omnibus cum apicibus nigris, syncarpio solitario terminali scilicet (ex photo) late ellipsoideo et 20 cm. long, 14 cm. diametro, phalangibus 4–4.3 cm. longis 3.2–4 cm. latis 2.8–3.1 cm. crassis in sicco pallide brunneis infra subluteis, lateribus planis vel cum sulcis vadosis paucis 4–6-angulosis, parte supera ⅛ libera, apice convexo, suturis lateralibus nullis, sinibus centralibus apicalibus 3–5 mm. profundis angustis, carpellis 12–14, plerumque 12, apicibus conicis sed valde oblatis et eis centralibus gradatim minoribus interioribus plerumque ½–⅔ tam grandis quam exterioribus, stigmatibus grandis prominentibusque centralibus elevatis sed subhorizontalibus interioribus 3–4 mm. longis 2–2.5 mm. latis ellipticis exterioribus 2–3 mm. longis 3–4 mm. latis irregulariter cordatis, endocarpio centrali 1.7–2 cm. longo osseoso brunneo lateribus 1–3 mm. crassis, seminibus 11–14 mm. longis 4 mm. diametro late ellipsoideis, mesocarpio apicali in quaque carpella cavernoso cum membranis albis medullosis paucis, mesocarpio basali fibroso et carnoso.

DIAGNOSIS OF HOLOTYPE: Tree 5–6 m. tall, about 12 cm. in diameter; branches horizontal, then ascending; trunk gray, smooth; prop roots 1–2 m. long, about 4 cm. in diameter, smooth, many of them at 6–10 dm. from ground dividing into a cluster of smaller rootlets; leaves 1.2 m. long, 5.7 cm. wide, firm subcoriaceous, ligulate, broad M-shaped in section, long attenuate and at 10 cm. from the tip only 2.5 mm. wide, near the base the margins with very stout subulate teeth 3.5–5 mm. long, 8–18 mm. apart, ascending at 45°, the midrib below with mostly reflexed prickles 2–3 mm. long, 10–25 mm. apart, stout subulate; at the midsection the marginal teeth 3.5–4.5 mm. long, 5–15 mm. apart, appressed, stout subulate and heavy-based; the midrib below with prickles 2–3 mm. long, 13–23 mm. apart, appressed, mostly ascending; near the apex the margins and midrib below with prickles 0.6–0.8 mm. long, 7–14 mm. apart; all prickles with darkish tips; syncarp solitary, terminal, apparently broad ellipsoid and 20 cm. long, 14 cm. in diameter; phalanges 4–4.3 cm. long, 3.2–4 cm. wide, 2.8–3.1 cm. thick, quadrate-cuneate, apex convex, upper ⅛ free, sides smooth, shining, light brown, 4–6-angled, the sides flat or with a few shallow furrows, the lower half when dry still yellowish; central apical sinuses 3–5 mm. deep; carpels 12–14, mostly 12; carpel apices conic but the apex much depressed, those towards the center gradually smaller, the central ones ½–⅔ as large as the outer ones; stigmas centripetal, large and

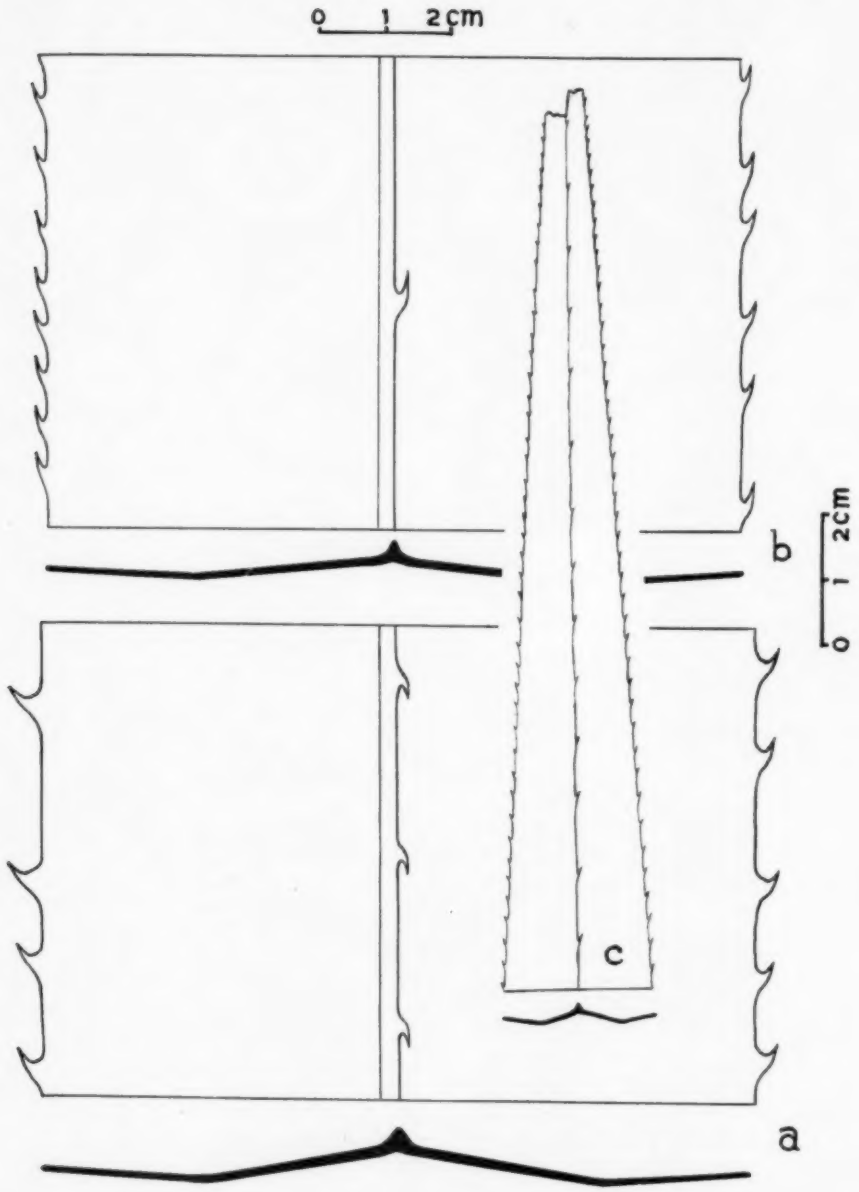

FIG. 14. *Pandanus Fosbergii*, from holotype. *a*, Leaf base, lower side, × 1; *b*, leaf middle, lower side, × 1; *c*, leaf tip, lower side, × 1.

prominent, the inner ones 3–4 mm. long, 2–2.5 mm. wide, elliptic, the outer ones 2–3 mm. long, 3–4 mm. wide, irregularly cordate, elevated, but more or less horizontal; endocarp central, 1.7–2 cm. long, bony, brown, the lateral walls 1–3 mm. thick; seeds 12–13 mm. long, broad ellipsoid; apical mesocarp with ellipsoid caverns mostly empty but with a few transverse white membranes; basal mesocarp fibrous.

HOLOTYPUS: Maldive Islands, Haddumati Atoll, Hitadu Islet, common near shore, Oct. 10, 1957, *W. D. Hartman 3* (Arn., Arb.).

DISCUSSION: *P. Hartmanii* is a member of the section *Pandanus*. The closest relative seems to be *P. tectorius* Soland. var. *spiralis* (Blanco) Martelli, of the Philippines. It has the carpels 6–9, and their apices low pyramidal-convex; and the leaves 5 cm. wide. *P. Hartmanii* has the carpels 12–14, and their apices conic but the apex much depressed; and the leaves 5.7 cm. wide.

This species is named for the anthropologist Dr. W. D. Hartman, member of the recent Yale University Expedition to the Indian Ocean. He collected all but one of the species of *Pandanus* known on the Seychelles Islands, and he collected excellent material of three new species on the Maldive Islands. His notes indicate the presence of others there which were either not in fruit or the fruits of which were not attainable. Because of his excellent collections of these difficult plants it is a pleasure to name this species for him.

Pandanus Karikayo sp. nov. (sect. *Pandanus*)
Figs. 16–17

NOM. VERN. "karikayo."

DIAGNOSIS HOLOTYPI: Arbor 4–5 m. alta scilicet 15 cm. diametro, corona ovoidea, cortice sublaevi, radicibus fulturosis evidentibus, foliis 100–125 (–300?) cm. longis 5.2 cm. latis ligulatis subcoriaceis longe attenuatis ad basem V-formatis sed ultra planis in regione basali marginibus cum aculeis 0.5–1 mm. longis 3–5 mm. distantibus salientibus, in regione 15 cm. ex basi cum aculeis 5–7 mm. longis 13–26 mm. distantibus subulatis in 45° adscendentibus, midnervio infra cum aculeis 4–4.5 mm. longis 15–30 mm. distantibus crassiter subulatis recurvatis, in sectio mediale marginibus cum aculeis 5–7 mm. longis 13–26 mm. distantibus adscendentibus, midnervio cum aculeis infra 3.5–4 mm. longis 15–30 mm. distantibus recurvatis, circa apice marginibus midnervioque cum aculeis 0.6–1 mm. longis 3–8 mm. distantibus crassiter subulatis adpresse adscendentibus, aculeis paene totis pallidis, syncarpio unico terminali scilicet 18 cm. longis et 13 cm. diametro rubro late ellipsoideo, phalangibus multis 3.8–4.4 cm. longis 2.1–3.4 cm. latis 2–2.6 cm. crassis obovoideocuneatis apice subconvexo parte ¼ supera libera lateribus laevibus lucidis in sicco pallide brunneis curvatis vel minime sulcatis 4–5-angulosis, suturis lateralibus nullis, sinibus apicalibus centralibus 4–8 mm. profundis omnibus angustis vel paucis cum fundam latam, carpellis 10–14 et rare cum carpella laterali abortiva, apicibus conicis adscendentibus depresse subrotundatis omnibus aequalibus vel centralibus minoribus ⅔ tam grandibus quam marginalibus eis saepe conicis asymmetricalibus et clare divengentibus, stigmatibus 1.5–2.5 mm. longis ellipsoideis obliquis elevatis prominentibus centripetalibus breve sulcatis, sutura proximali ⅓ distancia ad fundam extenta, endocarpio centrali osseoso mahogani-colorato marginibus lateralibus 1.5–2 mm. crassis, seminibus 10–11 mm. longis ellipsoideis, mesocarpio apicali in quaque carpella cavernoso fibroso et cum membranis subalbis medullosis, mesocarpio basali cum fibris fortibus.

DIAGNOSIS OF HOLOTYPE: Trees 4–5 m. tall, about 15 cm. in diameter; trunk rather smooth; crown ovoid; prop roots diverging at about 40°; leaves 100–125 (–300?) cm. long, 5.2 cm. wide, subcoriaceous, ligulate, long attenuate, towards the base V-shaped, beyond it plane, near the base the margins with salient prickles 0.5–1 mm. long, 3–5 mm. apart, but at 15 cm. up from the base the prickles 5–7 mm. long, 13–26 mm. apart, subulate, ascending at 45°, the nearby midrib below with prickles 4–4.5 mm. long, 15–30 mm. apart, stout subulate, recurving; at the middle the margins with prickles similar to those near the base but ascending at 25°–40°, the midrib below with prickles 4–4.5 mm. long, 15–30 mm. apart, stout subulate, recurving; near the apex the margins and midrib below with prickles 0.6–1 mm. long, 3–8

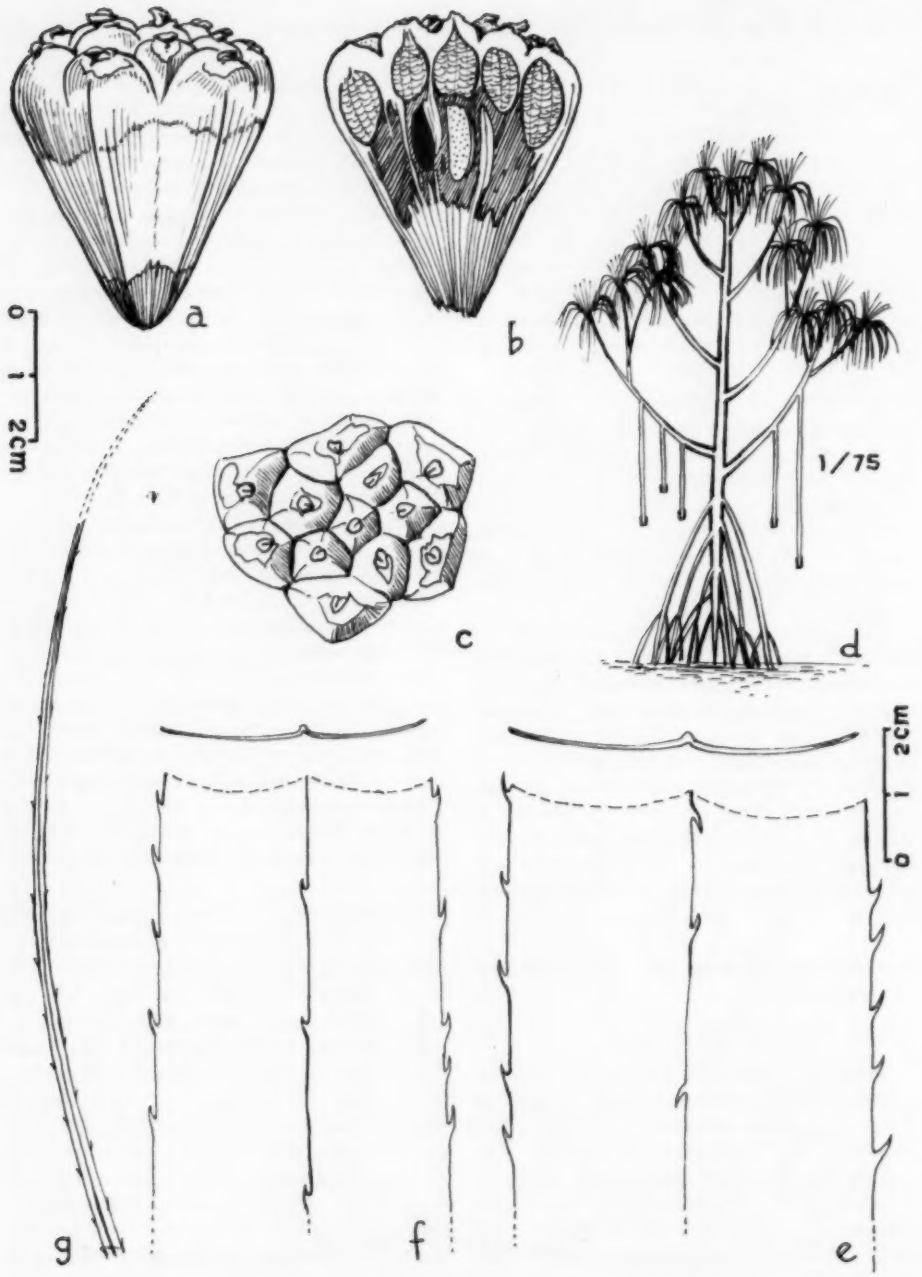

FIG. 15. *Pandanus Hartmanii*, from holotype. *a*, Phalange, lateral view, × 1; *b*, phalange, longitudinal section, × 1; *c*, phalange, apical view, × 1; *d*, tree, × 1/75; *e*, leaf base, lower side, × 1; *f*, leaf middle, lower side, × 1; *g*, leaf tip, lower side, × 1.

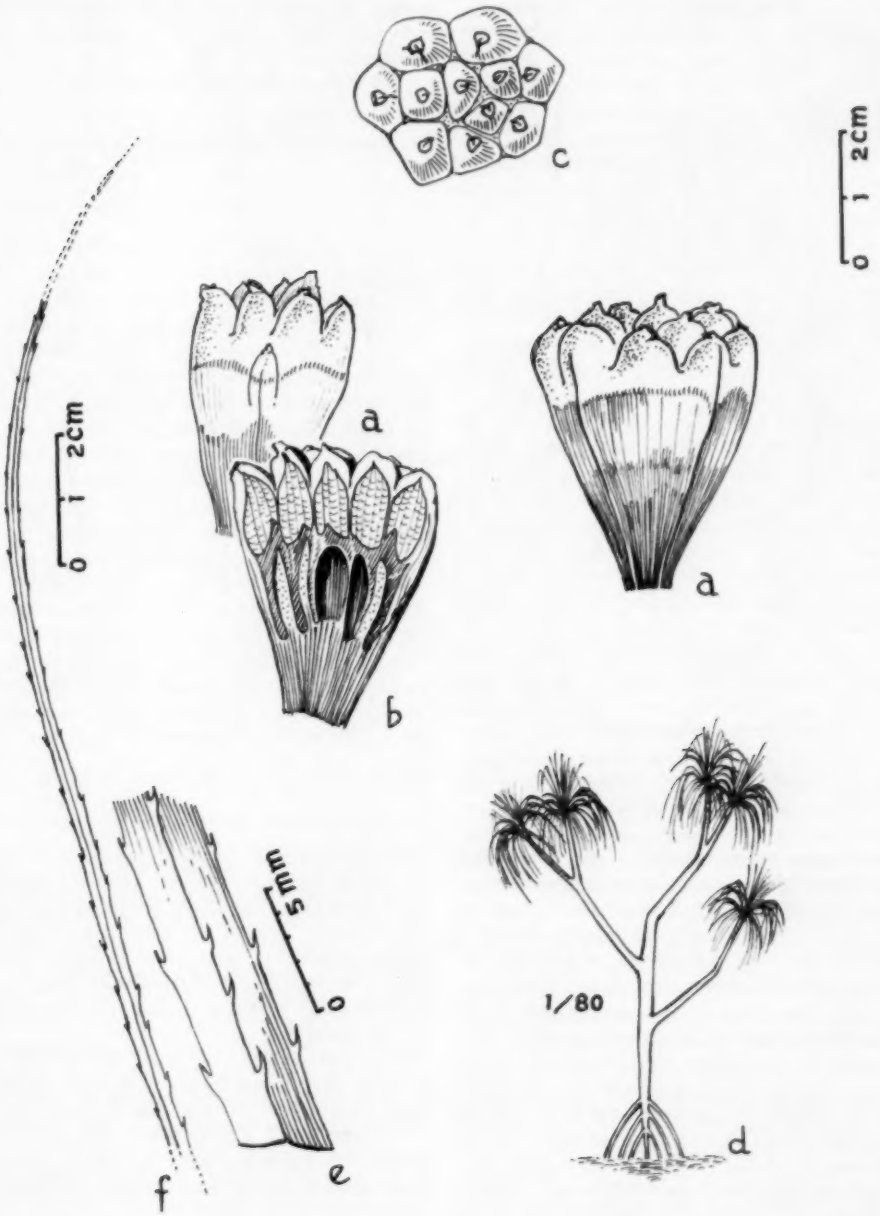

FIG. 16. *Pandanus Karikayo*, from holotype. *a*, Phalanges, lateral view, × 1; *b*, phalange, longitudinal section, × 1; *c*, phalange, apical view, × 1; *d*, tree, × 1/80; *e*, leaf apex, lower side, × 4; *f*, leaf apex, upper side, × 1.

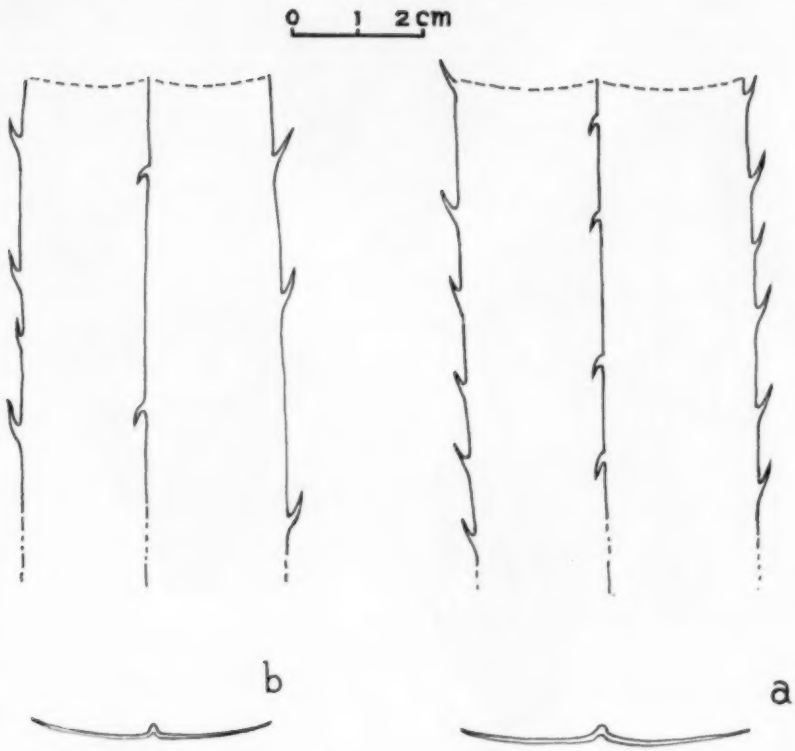

FIG. 17. *Pandanus Karikayo*, from holotype. *a*, Leaf base, lower side, × 1; *b*, leaf middle, lower side, × 1.

mm. apart, stout subulate, closely ascending; prickles all pale; syncarp single, terminal, broad ellipsoid, apparently 18 cm. long, 13 cm. in diameter, "bright red"; phalanges numerous, 3.8–4.4 cm. long, 2.1–3.4 cm. wide, 2–2.6 cm. thick, obovoid-cuneate, apex slightly convex, upper ¼ free, sides smooth, shining, when dry light brown, curving or slightly channeled, 4–5-angled; lateral sutures none; apical central sinuses 4–8 mm. deep, all narrow or a few broad based; carpels 10–14, rarely with a tiny, lateral, splintlike one also; carpel apices ascending, depressed, somewhat rounded conic, but the marginal ones often conic, asymmetric and distinctly divergent, all subequal or the ones toward the center somewhat smaller, these about ⅔ as large as the marginal ones; stigmas 1.5–2.5 mm. long, ellipsoid, short creased, prominent, raised, oblique, centripetal; proximal suture extending ⅓ way to the valley bottom; endocarp central, bony, mahogany-colored, the lateral margins 1.5–2 mm. thick; seeds 10–11 mm. long, ellipsoid; apical mesocarp in each carpel forming a large cavern with strong longitudinal fibers and whitish pithy partitions; basal mesocarp with strong fibers.

HOLOTYPUS: Maldive Islands, Fadiffolu Atoll, Kuredu Islet, common on shore and middle, Sept. 25, 1957, *W. D. Hartman 1* (Arn. Arb.).

DISCUSSION: *P. Karikayo* is a member of the section *Pandanus*. Its closest relative appears to be *P. odoratissimus* L. *f.*, of the island of Ceylon, which has the phalanges with the upper ⅓ free; the central apical sinuses 4 mm. deep; and the stigmas of the outer carpels horizontal. In *P. Karikayo* the phalanges have the upper ¼

free; the central apical sinuses 4–8 mm. deep; and the stigmas of the outer carpels divergent.

The new specific epithet is the vernacular name of the species on Fadiffolu Atoll.

Pandanus maldivecus sp. nov. (sect. *Pandanus*)
Fig. 18

NOM. VERN.: "karikayo."

DIAGNOSIS HOLOTYPI: Arbor 2–6 m. alta, trunco scilicet 12 cm. diametro cum foliis subpersistentibus, radicibus fulturosis scilicet 3–6 dm. longis et laevibus, foliis 117 cm. longis 4 cm. latis ligulatis subcoriaceis longiter attenuatis in sectio ad basem W-formatis ad mediam planatis, apice longe acuminato et in 10 cm. ex apice 2.5 mm. lato, ad basem marginibus cum aculeis 2–4.5 mm. longis 9–22 mm. distantibus crassiter subulatis adscendentibus, midnervio ad basem infra cum aculeis 2–3 mm. longis 1–3 cm. distantibus subulatis valde reflexis, in regione mediali marginibus cum aculeis 1.5–2.5 mm. longis 8–17 mm. distantibus, midnervio infra cum aculeis 1.5–2 mm. longis 15–22 mm. distantibus subulatis adscendentibus, proxima apice marginibus cum dentibus 0.3–0.5 mm. longis 3–7 mm. distantibus, aculeis omnibus cum apice nigro, syncarpio solitario terminali 14 cm. longo 11 cm. diametro late ellipsoideo cum circa 60 phalangibus eis 4.8–5.2 cm. longis 2.5–3.4 cm. latis 2.2–2.9 cm. crassis obovoideis cuneatis scilicet luteis in sicco pallide brunneis laevibus lucidis lateribus planatis vel rare vadoso-sulcatis 4–6-angulosis parte ¼ supera libera, apice convexo sinibus apicalibus centralibus 2–3 mm. profundis angustis vel latis, carpellis 5–9 plerumque 6, apicibus valde depresso-pyramidalibus eis marginalibus clariter cum apice et stigmate divergenti, apicibus interioribus minoribus, centralibus ⅔ tam grandis quam marginalibus, stigmatibus 2.5–3.5 mm. longis ovatis vel rhombicis prominentibus elevatis centripetalibus, sutura proximali ¼ distancia ad fundum extenta, endocarpio paene submediali osseoso obscure mahogani-colorato marginibus lateralibus 1.5–2 mm. crassis, seminibus 11–13 mm. longis 4 mm. diametro asymmetriciter ellipsoideis, mesocarpio apicali cum cavernis cum membranis firmis albis completis, mesocarpio basali fibroso et carnoso.

DESCRIPTION OF ALL SPECIMENS EXAMINED: Tree 2–6 m. tall, and about 12 cm. in diameter, the bark and roots appearing smooth; trunk usually more or less clothed with persistent, dead leaves; leaves 117 cm. long, 4–5 cm. wide, ligulate, subcoriaceous, towards the base W-shaped, further out plane, then long attenuate, the apex 10 cm. back only 2.5 mm. wide; near the base the margins with prickles 2–4.5 mm. long, 9–22 mm. apart, stout subulate, ascending; the midrib the only prominent nerve, and near the base with prickles below 2–3 mm. long, 1–3 cm. apart, strong subulate, reflexed; near the middle the margins with prickles 1.5–2.5 mm. long, 8–17 mm. apart; the midnerve below with prickles 1.5–2 mm. long, 15–22 mm. apart, reflexed; near the tip the margins and midrib below with prickles 0.3–0.5 mm. long, 3–7 mm. apart; all the prickles dark-tipped; syncarp solitary, terminal, 14 cm. long, 11 cm. in diameter, broad ellipsoid, with about 60 phalanges, these 4.8–5.2 cm. long, 2.5–3.4 cm. wide, 2.2–2.9 cm. thick, obovoid, cuneate, apparently yellow, when dry pale brown, shining, the sides smooth, shining, plane or a few of them shallow furrowed, 4–6-angled, upper ¼ free, the apex convex; central apical sinuses 2–3 mm. deep, narrow or broad; carpels 5–9, mostly 6; carpel apices much depressed pyramidal, the marginal ones with apex and stigmas distinctly diverging, the others decreasing in size towards the center, the central ones being about ⅔ size of the marginal ones; stigmas 2.5–3.5 mm. long, ovate to rhombic, short creased, prominent, raised, centripetal; the proximal suture running ¼ way to valley bottom; endocarp slightly submedian, bony, dark mahogany-colored, the lateral margins 1.5–2 mm. thick; seeds 11–13 mm. long, 4 mm. in diameter, asymmetric ellipsoid; apical mesocarp with a cavern in each carpel, these filled with white, firm, cross membranes; basal mesocarp fibrous and fleshy.

HOLOTYPUS: Maldive Islands, South Malosmadulu Atoll, Dunikolu Islet, common, chiefly on the shore, Oct. 2, 1957, *W. D. Hartman 2* (Arn. Arb.).

SPECIMENS EXAMINED: Maldive Islands, Malé Atoll, Malé Islet, forming thicket back of seaward beach, 1–2 m. alt., nom. vern "bokio," fruits red on ripening, not eaten or used for

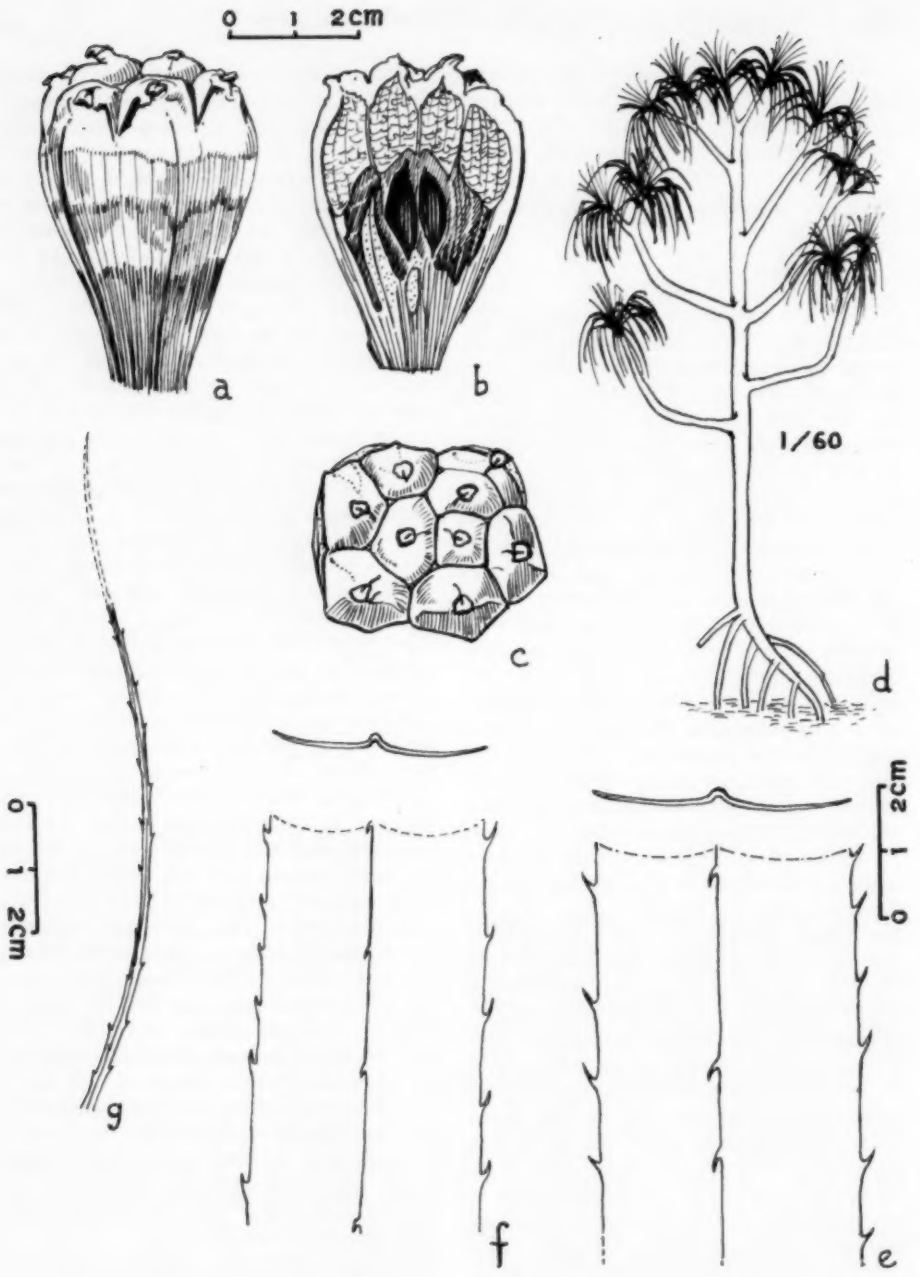

FIG. 18. *Pandanus maldivecus*, from holotype. *a*, Phalange, lateral view, × 1; *b*, phalange, longitudinal section, × 1; *c*, phalange, apical view, × 1; *d*, tree, × 1/60; *e*, leaf base, lower side, × 1; *f*, leaf middle, lower side, × 1; *g*, leaf apex, lower side, × 1.

anything, April 12, 1956, *F. R. Fosberg 36,916* (US).

DISCUSSION: *P. maldivecus* is a member of the section *Pandanus*. Its closest relative seems to be *P. tectorius* Sol. var. *sarawakensis* Martelli of Borneo. This has the phalanges 6–6.5 cm. long, the upper ½ free, the sides flat or more or less concave; central apical sinuses apparently 4–5 mm. deep; and the stigmas 2–2.8 mm. long, inflexed even on the marginal carpels. In contrast, *P. maldivecus* has the phalanges 4.8–5.2 cm. long, upper ¼ free, the sides plane and curved or shallowly furrowed; central apical sinuses 2–3 mm. deep; and the stigmas of the marginal carpels distinctly diverging.

The new specific epithet is taken from the geographic name Maldive, to which is added a Latin adjectival suffix.

Pandanus OF THE SEYCHELLES ISLANDS

Pandanus Balfourii Martelli, Webbia 1: 361–362, 1905; 4(1): 7, t. 4, figs. 4–7, 1913 (sect. *Pandanus*)
Fig. 19

This species was briefly described, then later illustrated by Martelli, from collections from the Seychelles made by Horne and by Dupont. It is a well-marked species, and its status is not in question. However, the collection, data, and photos by Dr. W. D. Hartman, made in 1957, make possible an expanded and more complete description, including stems, leaves, etc. The supplementary descriptive details are as follows:

Tree 5–6 m. tall, and at a point just above the roots 15–17.5 cm. in diameter, but below the first branches 20–23 cm. in diameter, appearing smooth; crown semiorbicular; prop roots borne up to 6 dm. from the ground; leaves 125–145 cm. long, 4.6–4.8 cm. wide, firm, strong, subcoriaceous, ligulate, M-shaped in cross-section, the tip long, slender acuminate to a subulate tip, this at 10 cm. down only 2 mm. wide, at 20 cm. only 8 mm. wide, near the base the margins with prickles 3–3.5 mm. long, 3–10 mm. apart, stout, broad-based subulate, salient ascending, the nearby midrib below beginning 12 cm. up with prickles 2.5–3 mm. long, 10–25 mm. apart, stout subulate, reflexed; at the midsection the margins with prickles 2–2.5 mm. long, 2–5 mm. apart, appressed ascending and more slenderly subulate, tipped with dark brown; the midrib below with prickles 1.5–2 mm. long, 7–15 mm. apart, slender subulate, ascending-subappressed; near the apex the margins and midrib below with prickles 0.3–0.5 mm. long, 2–3 mm. apart, stout subulate, broad based, appressed–ascending, brown tipped; phalanges 102; these 3.7–4 cm. long, 2–4.3 cm. wide, 1.6–2.5 cm. thick, upper 1/5–¼ free, apex low convex, sides gently convex or plane, shining, pale brown when dry; lateral sinuses none; lateral furrows none or slight, 4–6-angled, lower half fibrous and fleshy and orange; central apical sinuses 1–2 mm. deep, shallow, broad V-shaped; carpels 5–10, their apices low, rounded pyramidal, green when ripe; stigmas 1–2 mm. long, suborbicular to cordate; endocarp dark brown, slightly supramedian, the lateral margins 1–2 mm. thick.

SEYCHELLES ISLANDS: Mahé Island, opposite Souris Island, group on granite cliffs near shore, Nov. 9, 1957, *W. D. Hartman 6* (Arn. Arb.).

Pandanus Hornei Balf. *f.*, in Baker, Fl. Mauritius and Seychelles 397, 1877; Martelli, Webbia 4(1): 17, t. 16, figs. 1–3, 1913 (sect. *Dauphinensia*), new sectional placement
Figs. 20–21

NOM. VERN.: "vacoa parasol."

This very distinct species has been known for nearly a century. The phalanges were later illustrated by Martelli, but his figures did not clarify the remarkable stigmatic apparatus. Now, the recent collection and data by Dr. W. D. Hartman allow the furnishing of a supplementary description and more adequate illustrations, as follows:

Trees 15–20 m. tall, and the trunk at 3 m. from the ground 15–17.5 cm. in diameter, at 7–10 m. up 20–22.5 cm. in diameter, tall straight, twice trichotomous, then dichotomous; prop roots 2.4–3 m. long, nearly vertical and seeming to hug the trunk; leaf (1 seen) 2.25 m. long, 10 cm. wide, subcoriaceous, gradually tapering to the elongate apex (but the tip lost), at base 1-furrowed, further out M-plicate, at base the margin entire for 11 cm., then in-

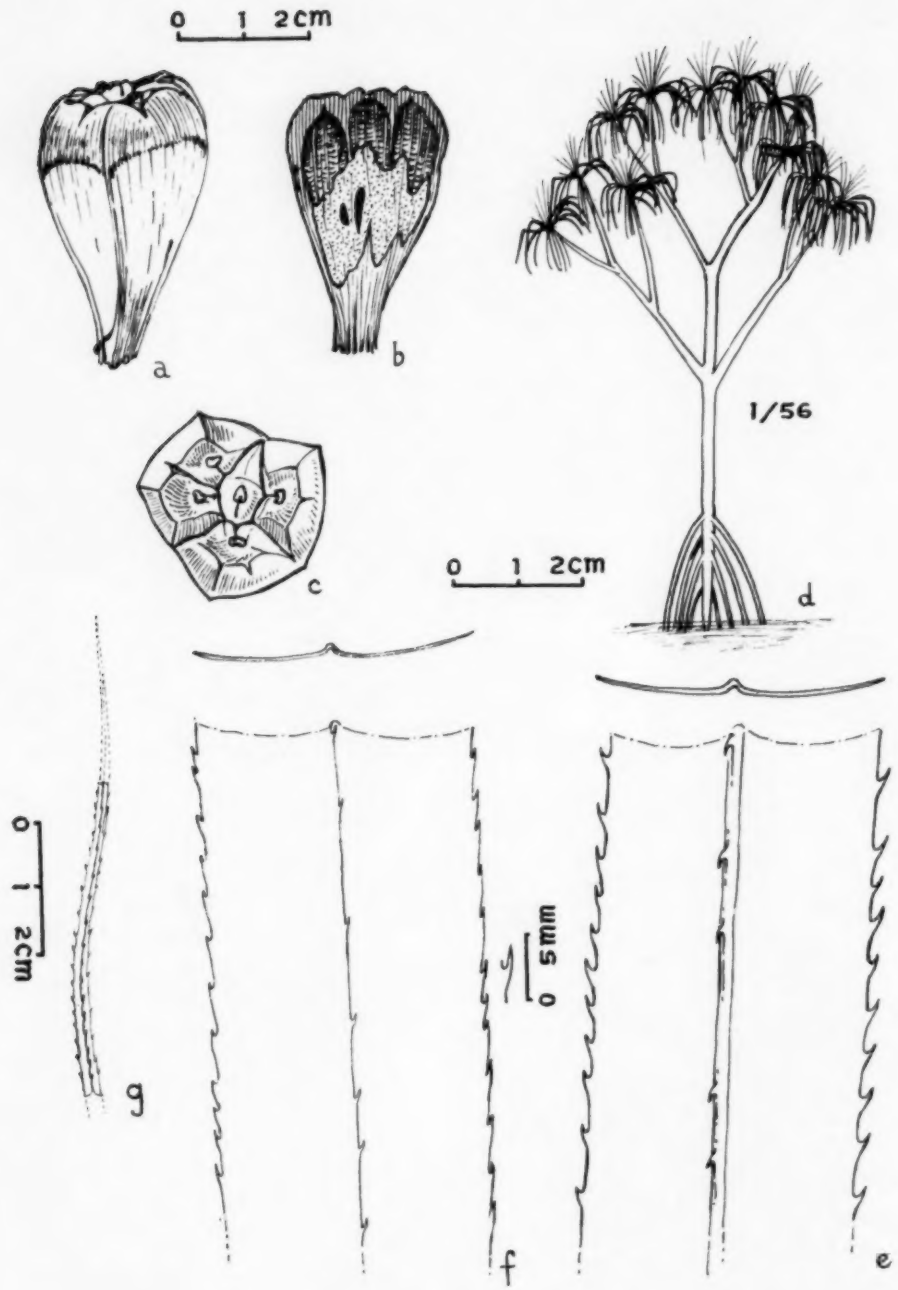

FIG. 19. *Pandanus Balfourii*, from Mahé I., *Hartman 6*. *a*, Phalange, lateral view, × 1; *b*, phalange, longitudinal section, × 1; *c*, phalange, apical view, × 1; *d*, tree, × 1/56; *e*, leaf base, lower side, × 1; *f*, leaf middle, lower side, × 1, and one prickle × 2; *g*, leaf apex, lower side, × 1.

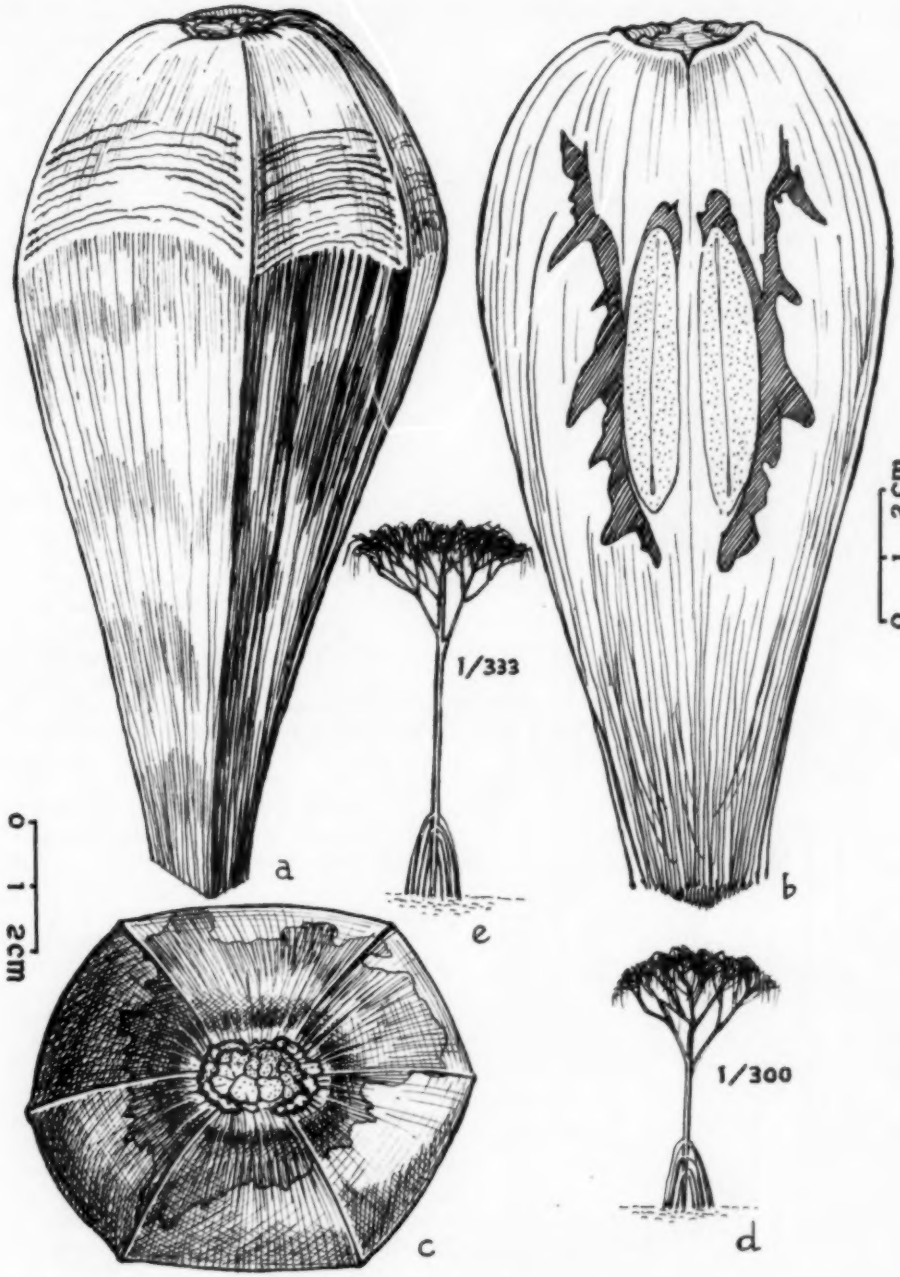

FIG. 20. *Pandanus Hornei*, from Praslin I., *Hartman* 7. *a*, Phalange, lateral view, × 1; *b*, phalange, longitudinal section, × 1; *c*, phalange, apical view, × 1; *d*, medium-size tree, × 1/300; *e*, large tree, × 1/333.

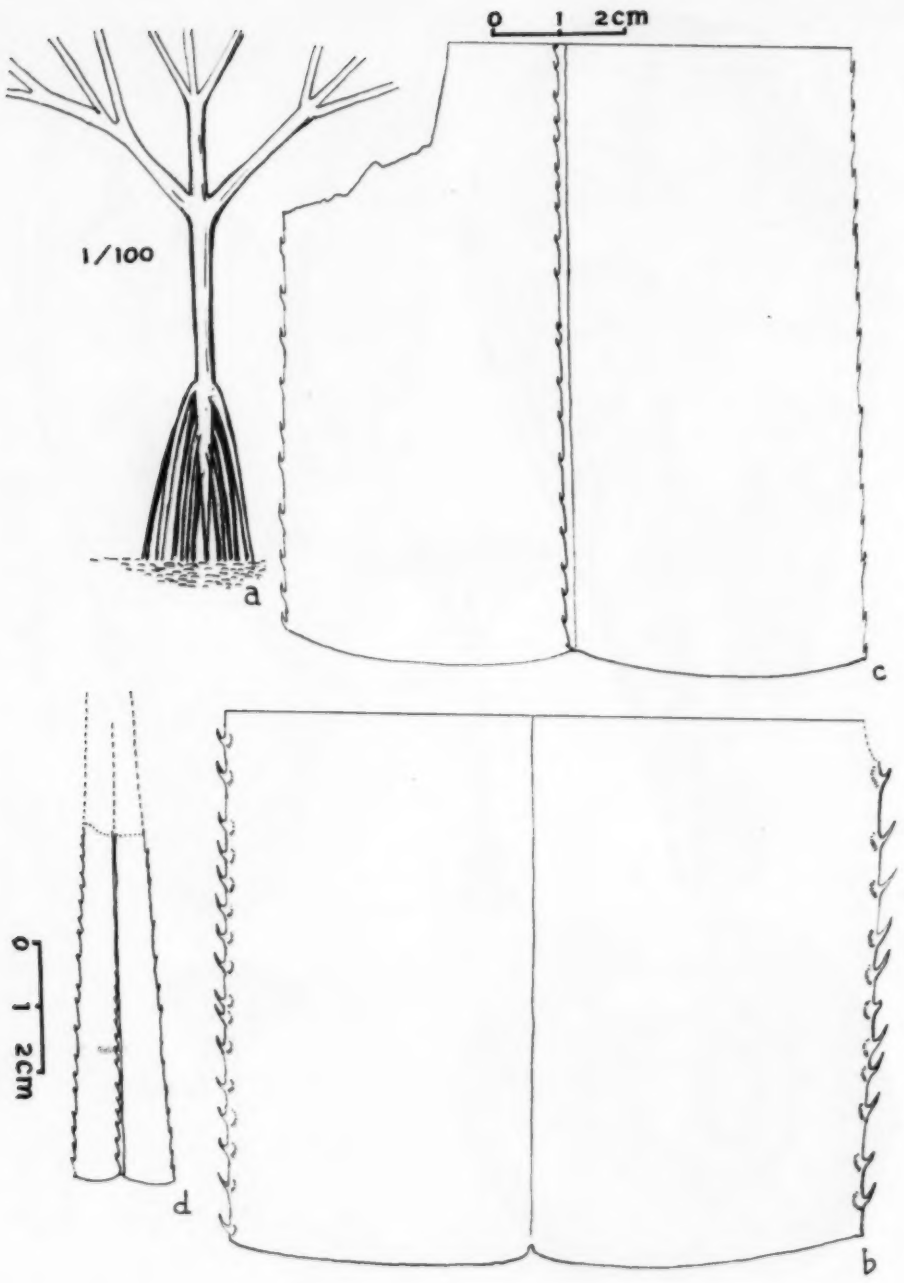

FIG. 21. *Pandanus Hornei*, from Praslin I., *Hartman* 7. *a*, Trunk, branches, and prop roots, × 1/100; *b*, leaf base, lower side, × 1; *c*, leaf middle, lower side, × 1; *d*, leaf apex, lower side, × 1.

creasingly coarsely aculeate, the prickles 3–4.5 mm. long, 3–10 mm. apart, stout subulate, upward curved, blackish; the nearby midrib unarmed; at midsection the marginal prickles 2 mm. long, 3–5 mm. apart, dark brown, subulate, upward curved; the midrib below with prickles 1 mm. long, 4–6 mm. apart, subulate, appressed ascending; near the tip the margins and midrib below with aculeate-serrations 0.2–0.4 mm. long, 1–2 mm. apart, brown, appressed ascending; pistillate inflorescences single, terminal; phalanges (4 seen) 12.2–13.2 cm. long, 5.3–6.8 cm. wide, 5–6.3 cm. thick, cuneate oblanceoloid, the apex rounded, upper ¼ free and green, glaucous, the lower ¾ fleshy, reddish orange, the sides smooth, above slightly convex, below plane; apex with a central rounded rim and within a concavity 2 mm. deep, the surface of which is covered by several irregular, unequal, cordate elevations which at first glance would seem to be stigmas, but are not these; and in some there is an apical central crack 1 mm. deep; along the apical rim are two arcuate or parenthesis-like, wavy ridges which are the two centripetal stigmas which along the perimeter are 20–22 mm. long; indocarp in upper 2/5, bony, dark brown, the lateral margins at the thinnest parts 3–4 mm. thick; seeds 45–46 mm. long, 10–11 mm. in diameter; mesocarp continuous, of solid pith and few longitudinal fibers.

SEYCHELLES ISLANDS: Praslin Island, Vallée de Mai, near stream, 500–600 ft. elev., Nov. 11, 1957, *W. D. Hartman* 7.

He also recorded, "Another stand of these trees was later seen (and photographed) growing along a stream near Newcombe Forest, Praslin Island. They were not quite as tall as the trees in the Vallée de Mai."

DISCUSSION: The crowded, cordate elevations in the apical concavity of the phalange are deceptively like stigmas. Only after careful study of the apex and of cut sections was it demonstrated that the actual stigmas were the two arcuate or parenthesis-like projections on the central apical rim. It would have been a pleasure to publish Hartman's excellent color photos of this species, but the cost forbids.

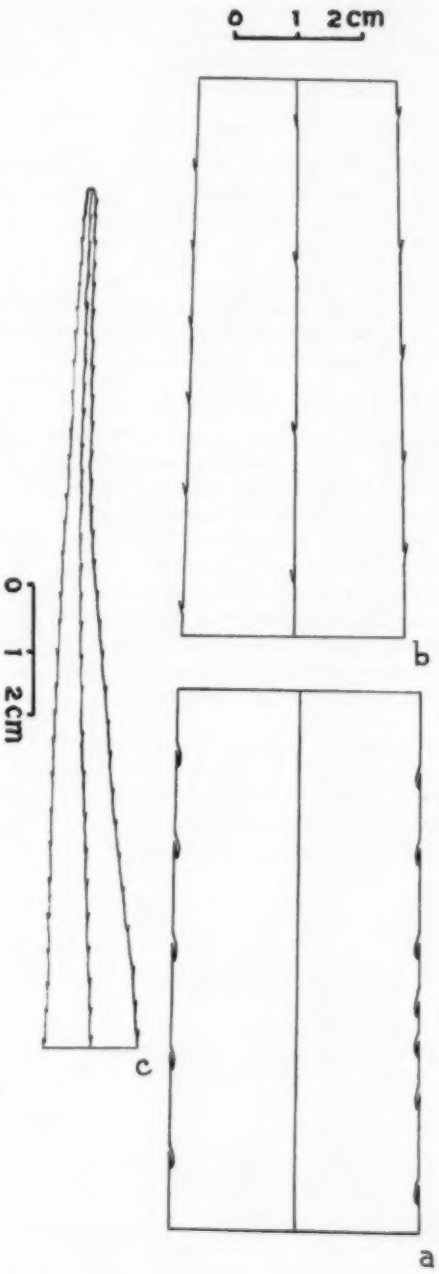

FIG. 22. *Pandanus sechellarum*, from Mahé I., *Hartman 5*. *a*, Leaf base, lower side, × 1; *b*, leaf middle, lower side, × 1; *c*, leaf apex, lower side, × 1.

Pandanus multispicatus Balf. *f.*, in Baker, Fl. Mauritius and Seychelles 403, 1877; Warburg, Engler's Pflanzenreich IV, 9: 67–68, 1900; Martelli, Webbia 4(1): 24, 1913 (sect. *Microstigma*)

SEYCHELLES ISLANDS: endemic.

Martelli's record of this species for Reunion Island was not confirmed by Vaughan and Wiehe (1953: 31). This species has never been illustrated.

Pandanus sechellarum Balf. *f.*, in Baker, Fl. Mauritius and Seychelles 402, 1877; Martelli, Webbia 4(1): 30, t. 7, figs. 6–8, 1913 Fig. 22

NOM. VERN.: "vacoa marron."

This was collected by Hartman in 1957, but since he found only half-grown fruits, his collection furnished only vegetative characters to supplement the known ones, as follows:

Prop roots present up to 6 dm. from ground; leaves 88–90 cm. long, 4–4.2 cm. wide, subcoriaceous, dark green above, paler below, ligulate, tapering gradually to the acute apex, this at the point 10 cm. down 11 mm. wide, M-shaped in section, the enlarged base entire, but beginning 10 cm. up the margins with prickles 1.5–2 mm. long, 7–16 mm. apart, acicular, appressed and seeming like a continuation of the margin since located above a concavity; the nearby midrib unarmed; at the midsection the teeth of the margins 1–1.5 mm. long, 11–26 mm. apart, acicular, appressed ascending; the midrib below with prickles 0.5–1 mm. long, 10–20 mm. apart, acicular, appressed ascending; near the tip the margins and midrib below with teeth 0.2 mm. long, 3–6 mm. apart, subulate, broad based, appressed ascending.

SEYCHELLES ISLANDS: Mahé Island, opposite Souris Island, group of 6–8 trees among granite boulders near shore, shaded by coconut palms, Nov. 9, 1957, *W. D. Hartman 5.*

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A Contribution to the Ecology of the Kermadec Islands

V. J. CHAPMAN[1]

IN 1956 and 1957, owing to the kindness of the Civil Aviation Department, to whom especial thanks are due, it was possible for two visits to be made to the Kermadec Islands. These visits were made under the aegis of the Botany Department, Auckland University, though on the first occasion the personnel included members from elsewhere. The first visit took place in May and June, 1956, and the members of the party were Dr. R. C. Cooper (botanist, Auckland Institute and Museum), P. L. Bergquist (Botany Dept.), and J. S. Edwards (Zoology Dept.). This party was originally expected to stay only a fortnight but, owing to circumstances beyond our control, they were there for a month. Transport facilities to the Kermadecs were generously provided by the Royal New Zealand Navy and return transport by the N. Z. Institute of Oceanography, to whom thanks are due. The second visit took place in October, 1957, when only one scientist could be accommodated on the normal supply vessel. The late D. Knowlton went on this occasion, and in the course of the three days available he was able to achieve much valuable work.

The original purpose of these visits was to set up permanent quadrats so that the regeneration of vegetation after the reduction of the goat population could be followed over a course of years. It is therefore hoped that further visits may be made in the future. The first visit in 1956 coincided with the end of a drive to eliminate the goats from the island, when some 1,500 goats were shot. About a hundred more were shot in 1956–57. As a result of these activities the goat population was reduced to the point where it could reasonably be hoped that it might be kept in check. Another purpose of the visits was to study more intensively the algal flora of the Kermadecs. It is true that earlier collections and lists had been made by the Gepps (1911) and by Cotton (1912), but in view of the importance of the Kermadecs in relation to sea temperatures and tropical influences, it was believed that a more intensive study would reveal the existence of more species of tropical affinities. This has indeed proved to be the case. Later, in another communication, it is intended to compare the flora of these islands with those from the North Cape region of New Zealand and Norfolk Island.

So far as the terrestrial flora is concerned, extensive lists were already in existence as a result of visits by Cheeseman in 1887 and by Oliver in 1909 to the islands. These earlier workers had collected methodically and extensively and there were no outstanding additions to be made to the earlier lists. One feature of interest was the way in which the taro, *Alocasia macrorrhiza*, had spread over the island since its introduction some time after 1909.

ALGAE

In the list that follows, algae recorded also by the Gepps (1911) are noted by *G* and those also recorded by Cotton by *C*. Algae newly added to the New Zealand flora are marked by †. Those not collected in 1956 or 1957 are marked by *.

MYXOPHYCEAE[2]

Chlorococcales

Anacystis thermalis (Menengh.) Dr. & Daily. Supralittoral fringe pool, Lava Pt.

Anacystis montana (Lightf.) Dr. & Daily. On rotten log, Green Lake; supralittoral fringe pool, Lava Pt.

Pleurocapsales

Entophysalis conferta (Kütz.) Dr. & Daily. Fleetwood Bluff, supralittoral fringe: on *Derbesia* 4–8 m. down, Meyer Is.

[1] The University of Auckland, New Zealand. Manuscript received November 7, 1960.

[2] I am grateful to Dr. F. Drouet for determinations of this group.

Nostocales

Lyngbya confervoides C. Ag. Fleetwood Bluff, supralittoral fringe; mid-littoral pool, Meyer I.; on *Pterocladia*, Lava Pt.

Lyngbya semiplena (C. Ag.) J. Ag. Fishing Rock, sheltered supralittoral pool, also Hutchinson's Bluff: on *Pterocladia*, Lava Pt.

Phormidium corium (Ag.) Gom. On *Pterocladia*, Lava Pt.

Phormidium autumnale (Ag.) Gom. Locality unknown.

Hydrocoleum glutinosum (Ag.) Gom. Fleetwood Bluff, sheltered crevice (mid-littoral), also supralittoral fringe.

Hapalosiphon laminosus Hansgirg. On fumarole orifice.

Tolypothrix tenuis Kütz. Supralittoral fringe pool, Lava Pt.

Scytonema hofmani Ag. On rotten log, Green Lake.

Amphithrix violacea (Kütz.) Born. et Flah. Fleetwood Bluff, supralittoral fringe.

Plectonema nostocorum Bornet. Supralittoral fringe pool, Lava Pt.

Calothrix crustacea Thur. Fishing Rock, sheltered supralittoral pool, also on wet concrete.

CHLOROPHYCEAE

Ulotrichales

G *Ulva lactuca* var. *rigida* (Ag.) Le Jol.

G **Ulva laetevirens* Aresch.

† *Enteromorpha kylinii* Bliding. The record of this species gives the alga a great discontinuity. In view of the relatively recent recognition of this species, however, it is likely that a wider distribution will be found for it than at present recorded. Supralittoral fringe, Hutchinson's Bluff, on rocks always wet with spray.

G * *Enteromorpha compressa* Grev.

Enteromorpha prolifera (Muel.) J. Ag. f. *crinata* (Roth.) comb. nov. Young plants which probably belong to this species. Supralittoral fringe, Meyer I.

Chaetophorales

Trentepohlia jolithus Wallr.

Oedogoniales

Oedogonium sp. } Neither fertile,
Bulbochaete sp. } Green Lake.

Siphonocladales

Lola tortuosa (Dillw.) Chapm. Fishing Rock, sheltered supralittoral pool.

Rhizoclonium hookeri Kütz. Fleetwood Bluff, on Pohutakawa log.

Rhizoclonium hieroglyphicum Kütz. emend Stockm. Waterfall near Hutchinson's Bluff; Blue Lake.

G C *Cladophora prolifera* (Roth) Kütz. This is recorded as *C. fusca* Marten by both the Gepps and Cotton. For a discussion on this matter the reader is referred to Chapman (1956). Deep mid-littoral pool, Lava Pt.; sublittoral, Meyer I. to 8 m.

Cladophora fracta (Dillw.) Kütz. var. *lacustris* (Kütz.) Brand ex Heering. Waterfall near Hutchinson's Bluff.

Cladophoropsis herpestica (Mont.) Chapm. Boat Cove, Fishing Rock.

† *Cladophoropsis membranacea* Borg.

† *Cladophoropsis membranacea* Borg. var. *repens* (J. Ag.) Phinney. I believe two plants have been confused here. There is a cushion-like *Cladophora, C. repens*, and there another plant which is clearly a *Cladophoropsis* in that the branches have no cells at the base. Supralittoral pool, Meyer I.

Microdictyon umbilicatum (Velley) Zanard. Only occurs elsewhere in New Zealand on Mayor I. (Chapman, 1956).

Dasycladales

† *Acetabularia parvula* Solms-Laubach. Mid-littoral pool, Fishing Rocks.

Siphonales

Derbesia novae-zelandiae Chapm. This was probably the plant that the Gepps recorded as *Vaucheria* sp. Pool in sublittoral fringe, pool mid-littoral, Fishing Rocks; sublittoral, 4–8 m., Meyer I.

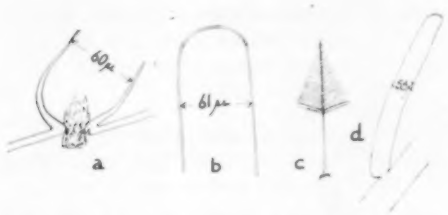

FIG. 1. *Bryopsis kermadecensis*. *a*, Base of pinnule showing constriction and plug of protoplasm; *b*, apex of pinnule; *c*, plant (× 2); *d*, pinnule.

† *Bryopsis kermadecensis* sp. nov. (Fig. 1). Plantis 1.5 cm. longis, axe primario distincto, simplici, 149–158 μ dia., pariete 6–6.5 μ crasso, partibus inferioribus nudis; pinnulis inferioribus caducis, pinnulis superioribus radialiter dispositis, basi constrictis, apici obtusis, 44–61 μ dia.

Plants 1.5 cm. long, main axis distinct, unbranched, 149–158 μ diam., wall 6–6.5 μ thick, lower part bare below; lower pinnules deciduous, upper pinnules radially arranged, constricted at the base, obtuse at the apex, 44–61 μ diam.

Type specimen in Lind. Herb. Auckl. Univ.

This species is very close to *B. derbesioides* Chapm., but differs in its smaller size and the greatly constricted bases of the branches. The diameter of the pinnules is also more uniform and the apices obtuse rather than tapering. It appears to be smaller than other species of *Bryopsis* recorded from the Australian mainland. For the present, therefore, it has been regarded as a new species, though extensive collecting will be necessary before any further decision can be made. On *Corallina* in sublittoral pool, Fishing Rocks.

G * *Codium dichotomum* (Huds.) S. F. Gray f. *novozelandicum* Dellow. This is the plant recorded by Gepp as *C. tomentosum*. (See Chapman, 1956.)

Codium adhaerens (Cabr.) Ag. var. *convolutum* Dellow. Sublittoral, Onerahi Bluff.

† *Caulerpa racemosa* (Forsk.) J. Ag. var. *peltata* (Lmx.) Eubank, Mid-tide pool, Fishing Rocks.

G *Caulerpa racemosa* (Forsk.) J. Ag. var. *uvifera* (Turn.) J. Ag. f. *intermedia* Web. van Bosse. Fishing Rock, mid-littoral pool: sublittoral, 12 m., and sublittoral fringe, Meyer I.

† *Caulerpa webbiana* Mont. Deep pool, mid-tide, Fishing Rock with *Corallina*; sublittoral, 12 m., Meyer I.

PHAEOPHYCEAE

Dictyotales

G *Dictyota prolificans* A. & E. S. Gepp. In red turf, Hutchinson's Bluff, mid-littoral.

C G *Taonia australasica* (Kütz.) J. Ag. Sublittoral, 4–8 m., Meyer I.

C G *Pocockiella nigrescens* (Sond.) Papenf. Pool, Boat Cove: in *Corallina* turf, sublittoral, Fishing Rocks.

Padina fraseri (Grev.) J. Ag. (Lindauer, 1957).

Hydroclathrus clathratus (Bory) Howe (Lindauer, 1957).

C * *Haliseris kermadecensis* Cotton

Sporochnales

C * *Perithalia capillaris* J. Ag.

Dictysiphonales

Colpomenia sinuosa (Roth.) Derb. et Sol. Fishing Rocks.

Fucales

C * *Sargassum sinclairii* Hook. f. & Harv. I think some doubt attaches to this identification.

G *Sargassum fissifolium* (Mert.) C. Ag. Fishing Rock, mid-tide pool: also in the sublittoral fringe, Lava Pt.

Carpophyllum phyllanthus, C. plumosum, C. maschalocarpum, Durvillea antarctica, and *Hormosira banksii* have all been recorded from the drift (Cotton, Gepp) but there is no evi-

dence that they grow there. The record of *Carpophyllum elongatum* is erroneous, as inspection of the material at Kew and the British Museum shows that the specimens are worn plants of *C. maschalocarpum* (Chapman, in press).

RHODOPHYCEAE

Bangiales

† *Porphyra denticulata* Levr. Previously only reported from Queensland. Sublittoral fringe, Lava Pt., and supralittoral fringe pool.

Nemalionales

G • *Chantransia* sp.

† *Nemalion helminthoides* (Velley) Batters. Very exposed rock faces, Fishing Rocks.

G • *Galaxaura laxa* Kjellm (as *Brachycladia marginata* Schm. in Gepp).

† *Galaxaura arborea* Kjellm. Mid-littoral pool, Meyer I.

† *Galaxaura rudis* Kjellm. Sublittoral, 16 m., Meyer I.

G † *Galaxaura fastigiata* Dcne. (as *G. lapidescens* in Gepp). Sublittoral, 3 m., Meyer I.

G *Asparagopsis taxiformis* (Delile) Collins & Hervey (= *A. sandfordiana*). Very common in sublittoral: extends into sublittoral fringe where exposure and wave action not great.

C G *Delisea fimbriata* (Lamour.) Mont. Sublittoral to 4–5 m., Meyer I. (= *D. pulchra, D. serrata*).

Chaetangium corneum J. Ag.

† *Chaetangium pulvinatum* Levr. Turf, mid-littoral, Fishing Rocks.

Gelidiales

G *Gelidium longipes* J. Ag. Fishing Rock. Mid-tide pool.

Gelidium crinale J. Ag. Turf, lower mid-littoral, Hutchinson's Bluff.

Gelidium pusillum Le Jol. Turf, lower mid-littoral, Hutchinson's Bluff.

Gelidium caulacantheum J. Ag.

C G *Pterocladia capillacea* (Gmel.) Born. et Thur. Fishing Rock, Lava Pt.: sublittoral, 4–8 m. Meyer I.

Cryptonemiales

G • *Peyssonnelia rubra* (Grev.) J. Ag.

C G *Corallina cuvieri* Lmx. Boat Cove (sparse); mid-tide pool, Fishing Rock.

G *Corallina officinalis* L. Mid-tide pool and sublittoral fringe, Fishing Rock; sublittoral, 4–8 m., Meyer I.

Jania rubens Lmx. Mid-tide pool and sublittoral fringe, Fishing Rock. This appears different from the local *J. micrarthrodia.*

G • *Amphiroa anceps* (Lmx.) Dcne.

GC • *Cheilosporum elegans* (Hook. f. & Harv.) Aresch.

Schmitziella cladophorae Chapm. On *Cladophora prolifera.*

Fosliella farinosa. On *Cladophora prolifera,* Lava Pt.

Gigartinales

C • *Plocamium costatum* J. Ag.

G C *Plocamium brachiocarpum* Kütz.

Plocamium angustum J. Ag. On *Pterocladia,* lower mid-littoral, Hutchinson's Bluff.

G • *Gracilaria confervoides* (L.) Grev. Drift.

Ceramiales

G *Martensia elegans* Hering. Sublittoral fringe in *Corallina* turf, Boat Cove: mid-tide pool, Fishing Rocks: sublittoral, 3 m., Meyer I.

Caloglossa leprieurii J. Ag.

G • *Nitophyllum decumbens* J. Ag. Drift.

G • *Euzoniella incisa* (J. Ag.) Falkbg.

G • *Spongoclonium brounianum* (Hook. f. & Harv.) J. Ag.

Microcladia novae-zelandiae J. Ag. Boat Cove, sparse.

G • *Laurencia forsteri* (Mert.) Grev. Drift.

† *Ceramium codii* (Richards) G. Mazoyer. On *Codium adhaerens.* The plants were not fruiting but habit and measurements agreed. Onerahi Bluff.

Centroceras clavulatum (C. Ag.) Mont. Epiphytic on *Pterocladia,* Hutchinson's Bluff; sublittoral, 12 m., Meyer I.

Total marine algae:	Myxophyceae	12
	Chlorophyceae	20
	Phaeophyceae	10
	Rhodophyceae	35

This is not an impressive list considering the variety of habitats available and the fact that the islands clearly lie in a zone where there is a mingling of cold and warm waters.

BRYOPHYTA

The mosses were kindly determined by the late Mr. G. O. K. Sainsbury and the liverworts by Mrs. Hodgson.

Musci

Fissidens pungens C. M. & Hpe.
Fissidens oblongifolius H. f. & W. First record for the Kermadecs.
Rhizogonium ?longiflorum (Mull.) Jaeg.
Rhizogonium spiniforme (Hedw.) Bruch. "Differs from type in having male flowers not synoicous and the perichaetial bracts lengthened. It looks as if some people would consider the Kermadecs plant to be a form of *R. longiflorum*."
Isopterygium minutirameum (C. M.) Jaeg.
Leucobryum candidum (Brid.) H. f. & W.
Echinodium hispidum (H. f. & W.) Jaeg.
Oxyrrhynchium compressifolium (Mitt.) Broth. "This is quite different from other allied forms (*Eurhynchium*) in New Zealand."
Papillaria flaxicaulis (Taylor) Jaeg.
Acanthocladium extenuatum (Brid.) Mitt. "Another first record" for the Kermadecs.
Rhacopilum ?pacificum

Hepaticae

Phaeoceros sp.
Chiloscyphus argutus Nees.
Lophocolea heterophylloides Nees.
Plagiochila sp.
Asterella sp.
Marchantia sp.
Radula sp.

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Feasibility of a Lava-diverting Barrier at Hilo, Hawaii[1]

C. K. WENTWORTH, H. A. POWERS, and J. P. EATON[2]

THE SUBJECT of the value and possibility of protecting Hilo Harbor and vicinity from devastation by a lava flow from Mauna Loa is again being given thoughtful consideration by the residents of Hawaii. Those who must weigh the pros and cons of this matter need information, part of which can best be appraised by geologists and engineers. From the geologists' appraisal should come answers to questions such as the following: How often might protection from a lava flow be needed? Is it physically possible to divert a lava flow with a man-made structure? What are the necessary dimensions of such a structure? Of what should it be built? What is its expected useful life?

Various references to cost have been made. Some say that a barrier is justified, regardless of cost; others hold to a strict accounting of supposed risk against cost, amortization, and other factors. These opposed views are widely separated. Many risks could be reduced by astronomical spending, but such spending may be beyond reasonable relation to contemporary life or even to capacity of the community to pay. Though opinions may differ greatly, the criterion of economic justification cannot be ignored altogether.

Much has been written on the subject of a lava barrier for Hilo. The latest and most comprehensive review and discussion is by Gordon A. Macdonald (1958). His greatest emphasis is laid on the matter of a barrier system to be constructed across the slope above Hilo to divert the course of an approaching lava flow. He concludes that a system of barriers can divert the course of a lava flow.

The conclusions reached in this report differ in this matter from those expressed by Macdonald because different evaluations are made of the same few facts available for appraisal. Among the most important of these different evaluations, this report concludes that the minimum condition for the successful functioning of a diversionary system is the construction of a channelway adequate to conduct the lava flow along the chosen route behind the barrier system. An adequate channel may exceed 2 mi. in width with rock excavation in excess of a 400-ft. depth along the upslope margin, even with a barrier 60 ft. high along the downslope margin. Facts needed to design the channel system and to appraise the amount of funds that can prudently be invested in it are imponderable—facts such as the volume of flow to be expected and the probable frequency of hazard. In the face of such imponderables, a downslope diversionary system is unrealistic; it would seem prudent to rely on, and plan for, defensive actions that can be taken during an eruption, such as causing distributary flows at or near the vent.

FORECASTING ACTIVITY

The waxing and waning of volcanic activity shown in the geologic history of Mauna Loa makes it impossible to give a dependable prediction of the *probable* hazard to Hilo from lava flows. The *possible* hazards cover a great range: Hilo might be obliterated by another eruption from the same vicinity as the prehistoric eruptions that formed the Halai Hills (see Fig. 1); or it is possible that no future lava flow will ever reach Hilo. Since Hawaiian oral history began, perhaps about A.D. 1100, only one lava flow from Mauna Loa, that of 1881, reached the vicinity of Hilo.

It is natural to predict future events on the premise that events of the best-known past will be repeated; in this instance, the history of Mauna Loa's activity since 1843. How disastrously wrong such a prediction can be was emphasized by the eruption in 1960 of the Kilauea lava flow in Puna. After the devastating flow in 1955, no further outbreak in that region was to

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[2] U. S. Geological Survey, Hawaiian Volcano Observatory, Hawaii National Park, Hawaii.

be expected for several decades, based on the spacing of recent known eruptions: 1740?, 1793?, 1840, and 1955 (Macdonald, 1941). Forecasts of Mauna Loa activity based on an even shorter period of time may be equally wrong; in fact, an inspection of a longer record shows that the activity of Mauna Loa waxes and wanes in a manner that gives no useful basis for predicting the frequency of future activity. In the 180 years since 1780 there have been 20 lava flows from the flanks of Mauna Loa; in the preceding 600 odd years covered by Hawaiian oral traditions there apparently were no lava flows from Mauna Loa; and, representing activity previous to A.D. 1100, 60 different ancient cinder cones can be found that indicate flank eruptions that took place over an unknown span of time. There is no geological basis for predicting how long the present epoch of frequent eruption may last; it may continue or it may have run its course.

The evidence for the dormancy of Mauna Loa during about 600 years covered by Hawaiian oral history is considered here in some detail, as it has not had the attention in the literature that it deserves. It consists of the evaluation of observations by early explorers and of geologists and evaluation of Hawaiian oral history and mythology.

Members of Captain Cook's expedition in 1778–79, particularly John Ledyard who attempted to climb the mountain, noted that Mauna Loa was a volcano and described features on the slopes " . . . that had every appearance of past eruption and fire. . . . But there is no tradition among the inhabitants of any such circumstance" (Hitchcock, 1909: 61–62).

Archibald Menzies, the botanist on one of Vancouver's expeditions, climbed to the summit crater of Mauna Loa in February, 1794; he contrasts "the Mountain" Mauna Loa with "the Volcano" Kilauea in his descriptions (Hitchcock, 1909: 68–72).

William Ellis, a British missionary who knew the Polynesian language, explored Hawaii in 1823 and queried the Hawaiians about volcanic activity. They had no oral history of lava flows from Mauna Loa but reported that Kilauea had been active from "time immemorial" and that some part of the lands of Kau and Puna had been devastated by a lava flow during the reign of every King (Hitchcock, 1909: 163–164).

The United States exploring expedition under Captain Wilkes spent nearly a month on the summit of Mauna Loa in the winter of 1840–41, having traversed the northeast ridge in the ascent (at that time, only one of the known historic eruptions had broken out from this region). They reported that the whole area was of lava, chiefly of very ancient date (Hitchcock, 1909: 83).

A large area of the southwest ridge of Mauna Loa was explored by R. H. Finch of the U.S. Geological Survey during December, 1925. He observed, "The lava on the southwest flank of Mauna Loa may well be divided into two ages: recent (within the last 100 to 150 years, say), and old. Lava flows of various ages showing a uniform gradation in weathering between the oldest and newest flows are not to be found" (Finch, 1925: 90).

There is thus some geologic evidence for a considerable period of dormancy of Mauna Loa, implied by the lack of mention of Mauna Loa flows in Hawaiian oral history. Moreover, recent seismological evidence that Kilauea's lava rises from a zone about 60 km. beneath the region between the Kilauea caldera and Mauna Loa's northeast rift zone raises the possibility that both volcanoes are fed from the same source and that when one is in a period of unusual activity the other erupts infrequently. Such alternation in activity between the two volcanoes over century-long intervals is suggested by the historic evidence quoted above.

However, the Hawaiians were well aware of the fact that Mauna Loa was a volcano; many of their myths describing the activities of the demigods were explanations of volcanic features they found on the slopes of Mauna Loa. Pre-Hawaiian lava flows on the southwest slope are explained in the legend of "Na Pu'u o Pele" (Westervelt, 1916: 22–26); the lava flows that bank against the north slope of Mauna Kea were, to the Hawaiians, evidence of legendary conflicts between Pele and the snow-goddesses (Westervelt, 1916: 62); and the most recent lava flow in the forest south of Hilo was, to them, a record of the battle between Hi'iaka and Pana-'Ewa (Westervelt, 1916: 96–103). In

contrast, the lava island in Hilo Bay called Coconut Island was fished up from the sea by the demigod Maui (Westervelt, 1916: 28), apparently not associated in Hawaiian minds with the demigods to whom they attributed volcanic phenomena.

DIVERSION SYSTEM TECHNICALLY POSSIBLE

All who have considered the problem have agreed that a solution to containing a lava flow does not lie in impounding lava behind a dam; the topography is not favorable and the total amount of lava that would need to be stored cannot be estimated. The solution is sought, therefore, in some manner of diverting the course of flow. A lava flow following a natural channel can be entirely diverted along a chosen alternate channel if one fundamental condition is met—the artificial channel must be able to carry the lava away from the point of interception as rapidly as it is delivered there by the natural flow.

The average gradient of such a diversion channel will, of necessity, be considerably less than the average gradient of the natural slope across which it is constructed. To offset the unfavorable loss of gradient, the built channel must offer less obstruction in its floor, such as irregularities and vegetation, and provide space for a greater cross-section of flow. It is not enough to consider that a cross-section of a diversion channel is adequate by allowing an added area to compensate for the reduced gradient on the basis only of gravity flow of a liquid. Allowance must be made also for the capacity of the lava flow to transmit enough heat to maintain its liquidity. This differential term in the equation works against a wide flow, even though its greater width might sufficiently compensate reduced depth for water. If these conditions are met, the channel will direct the movement of the flow, and the barrier need only confine the downslope margin, not act as a dam across the flow.

However, if lava behind the barrier is ponded to a considerable depth (50 ft. or so), the possibility that it might inject itself through the barrier or its foundation cannot be overlooked. Such an engineering accident was responsible for the early failure of a barrier constructed during the 1960 eruption of Kilauea.

DESIGN OF THE DIVERTING SYSTEM

The designer of a system of structures to divert flowing lava must know the probable maximum rate of delivery of lava that can be expected to enter the system. Here again, geologic experience cannot predict the probable requirements, it can only point out the possible maximum load. If the outbreak takes place within 10 or 15 mi., lava may be expected to enter the system at a rate of about 25,000,000 cu. yd/hr, based on the observations made on the Mauna Loa eruption of 1950, the most voluminous eruption that has been sufficiently documented (Finch and Macdonald, 1953). Should the designer anticipate the voluminous load from a nearby eruption? What are the data upon which to make the decision?

The pre-Hawaiian lava flows that form the south shore of Hilo Bay (see Fig. 1) appear to have come from vents along the lower part of the northeast rift, according to current studies of recent air photographs and some reconnaissance field identifications. The topographic ridge built by these and similar eruptions is the south boundary of the topographic trough that slopes into Hilo Bay. Any future eruption along this rift line below an altitude of about 3,500 ft. will lie on the south side of the ridge, and its lava flows thus would be directed away from Hilo Bay; an eruption along this zone above about 3,500 ft. will be more than 15 mi. from Hilo. Any source vent closer to Hilo than 15 mi. would have to break through the flank of Mauna Loa considerably to the north of the zone of old cinder cones that mark the lower part of the northeast rift. However, Stearns and Macdonald (1946: 70) reasoned that the vents in Hilo (Halai Hills) lie on a branch of the northeast rift, and Macdonald restated the supposition in 1958 (p. 259). An eruption on any part of this supposed branch of the rift zone will be in the trough leading to Hilo; such an eruption must be expected geologically, even though there are no existing vents along this line between Hilo (Halai Hills) and a point 22 mi. from Hilo at

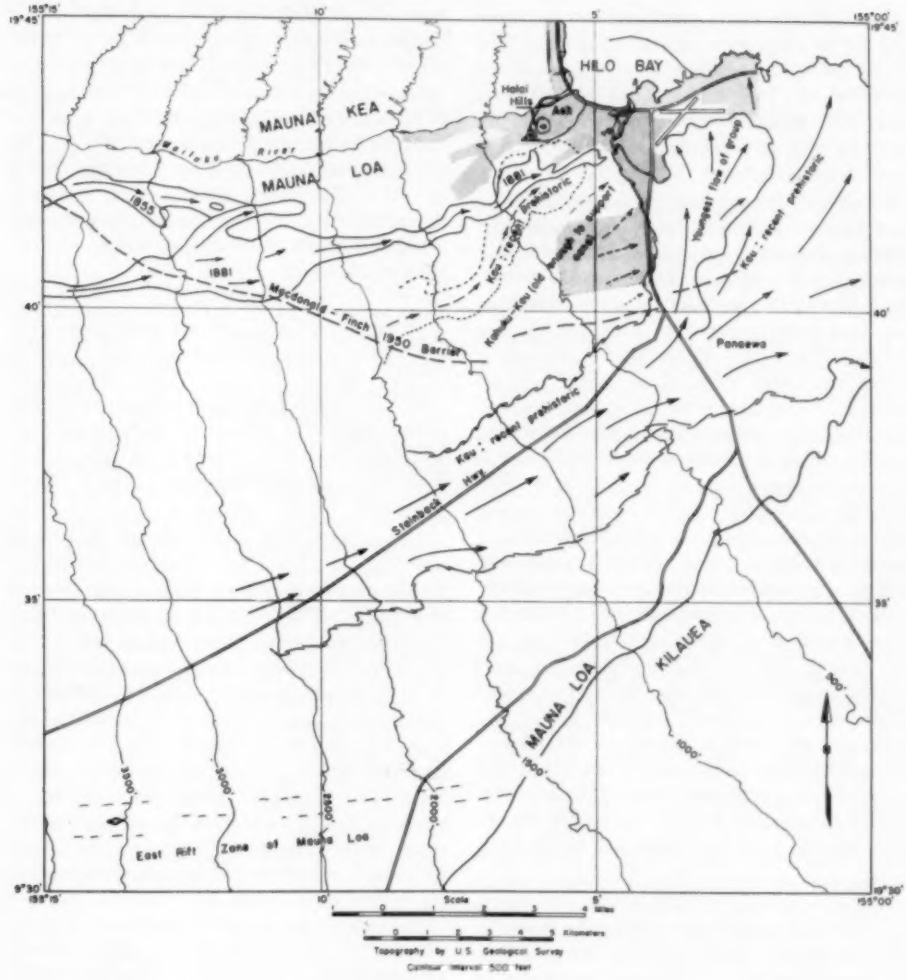

FIG. 1. Map of the vicinity of Hilo, Hawaii, showing historic and recent prehistoric lava flows from Mauna Loa that approached Hilo Bay. Shaded area represents present extent of the city of Hilo.

an altitude of 6,800 ft. Even if it is assumed that the reasoning of Stearns and Macdonald is incorrect (and there is no compelling geological basis for such an assumption), and that the supposed branch of the rift zone does not exist, there remains strong geologic precedent for an outbreak through any flank area away from a known rift zone. Of the 72 known flank eruptions, 18, or one-fourth, have broken through the mountain flank several miles away from any known rift zone. The eruption of 1877, above and in Kealakekua Bay (Hitchcock, 1909: 115), broke out as far from a rift zone as it is possible to be. There has been no eruption, in

the past, within 15 mi. upslope from the probable site of a diversion structure, but there is no known geologic reason why an eruption may not break through in this area. A reasoned decision about the necessary barrier design cannot be made on such data; the decision must be based on other considerations.

Another, and completely unrelated, problem of design for which no geologic or engineering solution is possible rises from certain characteristics of a lava flow (Wentworth, 1954). Every flow of lava inevitably sends out distributary flows from time to time and from place to place along its course, as one way of responding to frequent large fluctuations in the amount and rate of eruption of lava at the source vent. Therefore, it may be expected that more than one flow of lava will enter the channel of the diversion system during any one eruption. Inasmuch as mobile lava becomes immobile rock as soon as it cools slightly, a considerable amount of any lava that enters the channel system will solidify there and form an obstruction in the channel. Thus, any subsequent flow of lava that enters the channel system at a point upgrade will have to override this obstruction in order to keep on moving downgrade. If the channel system has been built with enough capacity, the overriding flow will be contained and the system will continue to function; if the system has too small a capacity at this point, the barrier wall of the channel will be overrun at the obstacle and the diversion system will fail to function.

At the designing stage of an adequate diversion system, it is obviously impossible to anticipate the point at which a future first lava flow will enter the system, to estimate the magnitude of the obstruction that it will form, or to appraise the amount of lava that may have to pass over the obstruction. The designer can cope with this situation only by overdesigning the entire system. He can only guess how much to overdesign:—twofold?—tenfold?

In considering design of barriers and diversion channels, the tendency of liquids adjacent to a dam to cause uplift pressure and to burrow through should be realized. To allow for such tendency is standard practice in designing dams, because some have failed in this way. Lava barriers have also failed in this way, as was recently observed in some instances at Kapoho. However, in the case of a massive barrier built of well-compacted rock and soil, this is thought to be a very remote contingency because of the cooling effect. Lava might retain liquidity through tenuous openings for a distance of 200 or 300 ft. but would seem unlikely to do so through 1,000 ft. or more except in a pre-established tube. Such an accident is not entirely dismissable, however.

SAMPLE ESTIMATES OF DIVERSION CHANNEL DIMENSIONS

We can neglect for the moment the imponderable matter of overdesign and consider the dimensions required to convey two sample lava flows that may be assumed to move as simple flow units.

The average natural gradient of the trough that leads to Hilo, which must be intercepted by the diversion system, is between 250 and 300 ft/mi. The diversion channel probably could be laid out with an average gradient of no more than 200 ft/mi. Estimates of the velocity of movement of lava flows on comparable low gradient can be made from published descriptions of previous flows. The hot, mobile lava near the vent of the 1954 eruption of Kilauea (Macdonald and Eaton, 1954) moved at rates not less than 400 yd/hr. A channel designed to move 25,000,000 cu. yd. of hot, mobile lava at this velocity would need to provide space for a flow cross-section of 63,000 sq. yd. If a containing barrier on the downslope margin of the channel were built high enough to give an average depth of flow of 20 yd. in the channel, the width of the channel would be 3,150 yd. (approaching 2 mi. wide), and the maximum rock excavation at the upslope margin would be greater than 400 ft.

A different example: the relatively cool and viscous lava of the 1926 flow that destroyed the beach village of Hoopuloa (Hawaiian Volcano Observatory, 1926) moved at rates not less than 60 yd/hr. A similar relatively cool flow from a distant vent reaching the diversion system at a rate of 2,000,000 cu. yd/hr would require a channel cross-section of nearly 34,000 sq. yd. to

carry the load at 60 yd/hr velocity. Assuming an average depth of 20 yd., the width of channel required is about 1,700 yd. (1 mi.) and the upslope would exceed 200 ft.

These examples have neglected the overdesign necessary to accommodate the transportation of distributary flows.

CHANGING THE MOVEMENT PATTERN OF LAVA FLOWS BY BOMBING

It has long been understood by observers of Hawaiian lava flows that the course and progress of a flow can be radically altered by breaching the levee bank of the main feeding channel. Macdonald (1958) presents an excellent discussion and evaluation of the matter which need not be repeated here. He concludes that efforts to divert the flows by bombing should be made in the event of a threat to Hilo, but that a barrier system also should be constructed as insurance against failure of the bombing effort, particularly in the event that a voluminous, fast moving flow would overrun the area before bombing could be carried out. However, it would seem from the discussion in previous paragraphs that an artificial diversion system of dimensions adequate to cope with a voluminous, fast moving flow would be expensive beyond prudent economic justification. Thus, it would seem that the hazard of being overrun by lava is one that must be accepted and lived with, perhaps analogous to the acceptance of earthquake harzards by Tokyo and cities in other earthquake areas.

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Variations in the Lava of the 1959 Eruption in Kilauea Iki[1]

GORDON A. MACDONALD and TAKASHI KATSURA[2]

IN RECENT YEARS the Hawaiian Islands have become of great importance in studies concerned with igneous petrogenic theory. This is partly because of the total absence in that region of sialic crust that might affect the formation of other rock types by its assimilation in rising magma. Partly, also, it is because of the extensive lateral and vertical exposure of successions of rocks, the structural and stratigraphic relationships of which are now well known. These conditions have attracted to the area workers from many parts of the world, and progress in knowledge of Hawaiian rocks has been rapid. The knowledge is, of course, the accumulation of the findings of many workers, starting with the visit of J. D. Dana to the islands in 1840, as a member of the U. S. Exploring Expedition. Outstanding among recent workers are Hisashi Kuno of Tokyo University, P. Niggli of the University of Zurich, C. E. Tilley of Cambridge University, H. S. Yoder of the Geophysical Laboratory of the Carnegie Institution of Washington, and H. A. Powers of the United States Geological Survey.

During 1960 and 1961 two studies have largely confirmed, but also extended and somewhat modified, the previous petrogenic picture. In April, 1960, the junior author of this paper, on leave from the Tokyo Institute of Technology, commenced a series of chemical analyses of Hawaiian lavas at the University of Hawaii under a National Science Foundation grant to the senior author. At the end of March, 1961, approximately 150 new analyses, primarily of the hitherto largely neglected "primitive" lavas of the Hawaiian volcanoes, had been completed. These have helped fill important gaps in the basic knowledge of Hawaiian rocks. Study of them is continuing.

During July, 1960, a core hole was drilled in the crust of the recently erupted lava pool in Kilauea Iki crater of Kilauea volcano, and penetrated into the molten lava beneath. The results of study of the drill-hole samples and samples of the earlier lava of the eruption are reported in this paper.

Acknowledgments. The core hole in the crust of the Kilauea Iki lava pool was drilled for the Lawrence Radiation Laboratory of the University of California in cooperation with the University of Hawaii, and the chemical analyses of the core samples were done at the University of Hawaii for the Lawrence Radiation Laboratory. The entire program is a part of the Lawrence Radiation Laboratory's Plowshare Program for the development of peaceful uses of atomic energy. The results of other aspects of the investigation will be published by members of the staff of the Lawrence Radiation Laboratory.

The drilling was done by a crew in the employ of Nat Whiton of Honolulu, under the general supervision of Walter Bennett and Donald E. Rawson of the Lawrence Laboratory. General scientific supervision was furnished by Macdonald. Thanks are due to the National Park Service for permitting the drilling for scientific purposes within Hawaii National Park, and to the Lawrence Radiation Laboratory for permitting us to publish the chemical analyses and other data on the core samples.

The sample of Pele's hair analyzed was collected and given to us by Mr. H. Ikawa, of the Department of Agronomy, University of Hawaii.

Two analyses (S-1 and S-2) in Table 1 are by J. H. Scoon of Cambridge University.

We wish to express our thanks to A. T. Abbott, of the University of Hawaii, for critical reading of the manuscript.

HAWAIIAN ROCK SUITES

In the classical Mull Memoir (1924), E. B. Bailey and his associates distinguished three principal rock types, which they termed the plateau, central porphyritic, and central nonporphyritic types. In 1933, W. Q. Kennedy applied the names *olivine basalt* and *tholeiite* to the first and

[1] Hawaii Institute of Geophysics, Contribution 23. Manuscript received March 21, 1961.

[2] University of Hawaii.

last types, respectively. In 1935, H. A. Powers recognized the presence of both these types in the Hawaiian Islands, though he did not employ the same terminology. Later Macdonald (1949*a*: 88) also pointed out that, although it had been thought by Kennedy to be absent from the oceanic areas, tholeiite is present in Hawaii. In 1955, Powers emphasized the essentially silica-saturated nature of the lavas of Mauna Loa and Kilauea. Although it had been anticipated to some extent by Powers (1935), C. E. Tilley (1950) was the first to definitely point out the presence of two distinct rock series in Hawaii. These he termed the *tholeiitic* and *alkali olivine basalt* series.

Tholeiite has been defined (Tilley, 1950; Kuno *et al.*, 1957) as a rock essentially saturated or slightly oversaturated with silica in which magnesian olivine bears reaction relationship to orthopyroxene and Ca-poor clinopyroxene. In contrast, alkali olivine basalt was defined as an undersaturated rock in which magnesian olivine and Ca-rich clinopyroxene undergo parallel crystallization. The characteristic groundmass pyroxene of tholeiite is pigeonitic, though the wollastonite content ranges from about 40 per cent to less than 10 per cent. That of alkali olivine basalt is Ca-rich augite. Hypersthene is present in some tholeiites.

Recently Kuno (1960) has pointed out the wide distribution of basalts resembling the central porphyritic type of Mull in their richness in alumina, but differing from it in being essentially nonporphyritic. High-alumina basalt of this type has not been found in the Hawaiian Islands, though some rocks containing abundant phenocrysts of feldspar are moderately high in alumina.

The predominant lavas of the great bulk of the visible part of the Hawaiian shield volcanoes contain scattered to moderately abundant phenocrysts of olivine, commonly as much as 5 mm. in diameter. These rocks have been called "olivine basalt" by Macdonald (1949*a*, *b*). Typically, however, the olivine phenocrysts are partly resorbed, and obviously were reacting with the remaining liquid at the time of consolidation of the rock. Chemical analyses show many of these rocks to be essentially saturated in silica, and the pyroxenes are lime-poor. They are thus typical tholeiites. They grade into other rocks that are otherwise similar but contain normative olivine. The extreme of the latter group is picrite-basalt of oceanite type, which may contain more than 50 per cent olivine phenocrysts. These rocks are chemically undersaturated with silica, and even with the attainment of complete equilibrium on crystallization should contain modal olivine. As in the more silica-saturated types, however, phenocrystic olivine commonly has separated in excess of its stoichiometric proportion, and was undergoing reaction with the liquid at the time of consolidation, as is indicated by their partial resorption. The groundmass pyroxene is largely or entirely lime-poor augite and pigeonite. Thus, although they are undersaturated with silica and therefore not true tholeiites, these rocks conform with Tilley's definition of tholeiite as a rock in which magnesian olivine bears a reaction relationship to Ca-poor pyroxene, and the entire group from the nonporphyritic true tholeiites to the picrite-basalts of oceanite type may be termed the *tholeiitic suite*.

Both Powers (1955) and Macdonald (1944) have pointed out that the variations within the tholeiitic suite can be largely accounted for by settling of olivine phenocrysts in the magma, though movement of minor amounts of pyroxene and plagioclase also probably are involved (Muir and Tilley, 1957; Macdonald, 1949*b*: 1576). Locally differentiation has yielded small amounts of iron-rich basalt and granophyre (Kuno *et al.*, 1957).

The major tholeiitic part of the Hawaiian shields is succeeded by a relatively small amount of lavas of other types, including alkali olivine basalt, picrite-basalt of ankaramite type, hawaiite (Macdonald, 1960), mugearite, and trachyte. This group may be called the *alkalic suite*, because of its relationship to alkali olivine basalt, and because the great majority of the members of the group contain a larger proportion of alkalies than do members of the tholeiitic suite that contain the same amount of silica. The lavas of the alkalic suite constitute only a few per cent of the total bulk of the Hawaiian volcanic mountains. The nature of the transition from the tholeiitic to the alkalic suite will be discussed in detail in a future report describing the results of the recent chemical analyses.

A still later group of lavas, which may be called the *nephelinic suite*, consists characteristically of nepheline basalt and melilite-nepheline basalt, but includes also basanites, and alkali olivine basalts ("linosaites") in which nepheline is present in the norm though not in the mode. The nephelinic suite is in general separated from the rocks of the other groups by a profound erosional unconformity (Stearns, 1946: 22).

THEORIES OF ORIGIN OF HAWAIIAN ROCK SUITES

There appears to be little or no question that the tholeiitic magma originates in the upper part of the earth's mantle, probably at a depth of about 30 or 40 mi., and that variations within the suite are largely or entirely the result of crystal differentiation. The same degree of certainty does not extend to the alkalic suite. Macdonald has previously attributed the formation of the more alkalic members of the alkalic suite to differentiation of a parent magma corresponding approximately in composition to the average basalt of Kilauea (Macdonald, 1949*a*: 92; Stearns and Macdonald, 1946: 205), or to an average of basalts from all Hawaiian volcanoes (Macdonald, 1949*b*: 1569). The former average corresponds with tholeiite only slightly undersaturated with silica. The latter average included alkali olivine basalts, and therefore is a little higher in alkalies and less saturated with silica than the Kilauean average. Calculations indicated that the alkalic rocks could be derived from either parent by crystal differentiation. To do so, however, it was necessary to hypothesize the separation of a large amount of pyroxene (both diopside and hypersthene) from the magma. Derivation of alkali olivine basalt per se was not considered, because it was not recognized as an independent rock type. The possibility of other differentiation processes, such as alkali transfer by volatiles, was also recognized.

Tilley (1950: 44–45) also attributed the various members of the alkalic rock suite to crystal differentiation of tholeiite, separation of hypersthene in place of olivine producing the alkali olivine basalt. Powers (1955) agreed to the importance of the movement of olivine crystals in producing the variations among the tholeiitic basalts, but pointed out, as indeed he had earlier (Powers, 1935), that crystal differentiation alone is inadequate to produce alkali olivine basalt from a *saturated* tholeiite.

It certainly is true that desilication of a magma by crystal differentiation can only result from the removal of crystals containing more silica than the magma. The removal of pyroxene from tholeiite can perpetuate a state of undersaturation in silica, but cannot bring it about. No mineral containing more silica than a saturated tholeiite magma is likely to form and separate except during the very latest stages of crystallization. Provided, however, that a distinctly undersaturated tholeiitic magma exists as a liquid, crystallization of pyroxene can not only perpetuate the undersaturation, but increase it. Murata (1960) has suggested that alkali olivine basalt is derived in this way from undersaturated tholeiitic magma.

Kuno *et al.* (1957: 212) agree with Powers that crystal differentiation cannot produce alkali olivine basalt from tholeiite. Instead, they assume the existence of two independent primary basalt magmas, tholeiite and alkali olivine basalt, formed by partial melting of peridotite at different levels in the mantle, incongruent melting of pyroxene at the higher level supplying extra silica for the tholeiite. More recently, Kuno (1960) has hypothesized still a third primary magma, high-alumina basalt, produced by melting in the mantle at a depth intermediate to the other two levels.

For several reasons, the existence of two primary basalt magmas in Hawaii appears improbable. Chemical analyses demonstrate a complete intergradation of the two types in composition (Figs. 1 and 3). Furthermore, it seems unlikely that melting at a deeper level in the mantle would produce a magma richer in alkalies than would melting at a shallower level. If anything, the reverse would be expected. These arguments are far from conclusive but, particularly when it is remembered that the rocks of the alkalic suite comprise only a very small proportion of the total, they do suggest that in some way alkali basalt magma is produced from tholeiitic magma, rather than having a wholly independent origin.

KILAUEA IKI LAVA

The pool of lava in Kilauea Iki crater, a pit crater immediately adjacent to the east edge of Kilauea caldera, was accumulated during the eruption that lasted from November 14 to December 20, 1959. The eruption consisted of 16 separate eruptive phases, from 2 to 167 hr. in length, separated by quiet periods of 8–101 hr. duration during which part of the lava flowed back into the vent from which it had issued (Macdonald, in press). Lava from fissures on the southwest wall of the crater about 300 ft. above the pre-eruption floor poured down the crater wall and formed a pool that gradually deepened until its surface was above the level of the original vents. Temperature measurements up to nearly 1200° C. were obtained on the lava fountain at the vent (Richter and Eaton, 1960). During eruptive phases lava was added to the crater fill partly by injection beneath the crust and partly by spreading over the previous crust. A new crust formed quickly on the molten lava as each successive outpouring covered the crater floor, but from time to time broke up and foundered during convective overturns in the liquid. The latter suggests that submerged crusts of previous eruptive phases had been largely destroyed (possibly accumulating as sunken fragments at the bottom), leaving a pool of melt that was essentially continuous from bottom to top. The final depth of the pool is approximately 380 ft.

In July, 1960, 7 months after the end of the eruption, the drill hole already mentioned was sunk into the solid crust of the lava in Kilauea Iki crater. Continuous core samples were taken, and cutting samples were preserved from successive drill runs to supplement the cores in intervals in which core recovery was poor. On July 25 the drill bit encountered very viscous semisolid material at a depth of 19.1 ft., and at 19.5 ft. it entered underlying liquid lava and started to sink into it. The tools were immediately removed from the hole, and a sample of the liquid that had congealed in it was removed from the bit. Additional samples were taken the next day by thrusting the drill pipe, without a bit, down into the liquid and withdrawing it. By the morning of July 28 liquid lava had risen in the hole to a level 18.7 ft. below the surface.

Eight samples from the drill hole, and one of the surface crust adjacent to it, have been analyzed chemically. They are listed in Table 1. Three analyses of lava extruded earlier in the eruption also are given. Of these, one is of Pele's hair wafted from the crater during the first days of the eruption. The other two (S-1 and S-2), by J. H. Scoon of Cambridge University, represent lava poured into the crater and spatter thrown onto the crater rim during the first eruptive period, between November 14 and 21.

Analyses 9 and 10 are of samples of the liquid lava that underlay the solidified crust. It will be noted that the two are not identical. Sample 10 is decidedly richer in alkalies. Sample 9 contains many more phenocrysts of olivine than sample 10, and is presumed to have come from a slightly lower level in the liquid.

Column 1 of Table 1 is an analysis of Pele's hair formed at the beginning of the eruption. Scattered phenocrysts of olivine were present in the Pele's hair, but none were included in the sample analyzed. The sample consisted essentially wholly of glass, even microlites being almost entirely absent. Therefore, the analysis represents magma that was completely liquid at the time of eruption. The norm indicates a notable degree of undersaturation of the liquid in respect to silica. It has generally been assumed that normative olivine in tholeiitic rocks is largely the result of addition to the magma of solid crystals of olivine that have sunk from higher levels. In the case of the Pele's hair of analysis 1 the undersaturation is not, however, the result of inclusion of olivine crystals in the analyzed sample. The liquid phase of the magma was itself undersaturated. Yet its very low content of alkalies and alumina mark it clearly as a member of the tholeiitic suite. It is close to the value suggested by Bowen (1928: 164) as the limit of undersaturation in completely liquid basaltic magmas, though less undersaturated than some rocks believed by Drever (1956) to have been derived from completely liquid magmas.

In thin section the samples from the upper 17 ft. of the drill hole differ from each other almost entirely in the abundance of olivine phenocrysts, which range from about 10 per cent in the sample from 16.5 ft. to 40 per cent in that from 7.5 ft. The latter is a picrite-basalt of oceanite

TABLE 1

CHEMICAL ANALYSES OF LAVAS OF THE 1959 ERUPTION IN KILAUEA IKI

	1	2	3	4	5	6	7	8	9	10	11	S-1	S-2
SiO_2	48.82	46.77	46.99	44.58	45.61	45.63	47.24	48.25	48.43	47.73	38.85	48.91	48.13
Al_2O_3	13.42	12.04	12.14	9.25	9.06	10.58	11.14	12.90	13.00	14.58	0.31	12.42	11.62
Fe_2O_3	1.70	1.72	2.55	1.27	1.32	1.85	1.41	1.78	1.32	1.36	0.55	1.34	1.27
FeO	9.90	9.95	9.19	10.76	10.49	10.26	10.22	9.88	11.25	12.99	12.21	10.23	10.40
MgO	9.00	14.85	14.33	23.46	21.48	18.41	15.66	11.39	9.39	6.01	47.69	10.96	13.78
CaO	11.32	9.89	9.90	7.18	7.79	8.40	9.56	10.38	10.03	8.92	0.00	10.44	9.64
Na_2O	2.25	1.53	1.51	1.10	1.28	1.31	1.53	1.75	2.10	2.43	0.00	2.20	2.04
K_2O	0.58	0.38	0.40	0.29	0.30	0.38	0.39	0.45	0.60	0.98	0.00	0.54	0.50
H_2O+	0.02	0.19	0.28	0.10	0.27	0.18	0.23	0.35	0.04	0.09	0.15	0.02	0.01
H_2O-	0.02	0.04	0.06	0.04	0.20	0.23	0.14	0.07	0.25	0.00		0.00	0.00
TiO_2	2.77	2.28	2.24	1.73	1.77	2.05	2.20	2.52	2.98	3.95	0.05	2.64	2.38
P_2O_5	0.24	0.24	0.25	0.19	0.16	0.25	0.15	0.28	0.32	0.43	0.00	0.25	0.23
MnO	0.18	0.18	0.18	0.18	0.17	0.18	0.16	0.18	0.18	0.20	0.16	0.15	0.18
Total	100.22	100.06	100.02	100.13	99.90	99.71	100.03	100.18	99.89	99.67*	99.97	100.10	100.18

NORMS

or		3.34	2.22	2.22	1.67	1.67	2.22	2.22	2.22	3.34	6.12	.....	2.78	2.78
ab		18.86	13.10	12.58	9.43	11.00	11.00	13.10	14.67	17.82	20.44	.....	18.34	17.29
an		24.74	24.74	25.30	19.18	18.07	21.96	22.24	26.13	24.19	26.13	.....	22.80	21.13
di	wo	12.30	9.86	9.63	6.61	8.12	7.89	10.21	9.86	9.86	6.38	.....	22.24	20.43
	en	7.50	6.70	6.60	4.70	5.70	5.50	7.00	6.30	5.80	2.90	.....		
	fs	4.09	2.38	2.24	1.32	1.72	1.72	2.38	2.90	3.56	3.43	.....		
hy	en	9.30	10.20	13.80	10.00	9.40	10.70	11.30	15.50	12.60	8.40	.....	16.08	12.83
	fs	5.02	3.56	4.49	2.77	2.64	3.30	3.96	7.13	7.79	10.16	.....		
ol	fo	3.99	14.14	10.64	28.35	26.53	20.86	14.63	4.69	3.57	2.59	.....	10.25	18.70
	fa	2.55	5.71	3.88	8.46	8.67	7.14	6.02	2.34	2.55	3.57	.....		
mt		2.55	2.55	3.71	1.86	1.86	2.78	2.09	2.55	1.86	2.09	.....	1.86	1.86
il		5.32	4.41	4.26	3.34	3.34	3.95	4.26	4.71	5.78	5.62	.....	5.02	4.56
ap		0.67	0.34	0.34	0.34	0.34	0.34	0.34	0.67	0.67	1.01	.....	0.67	0.51

1. Pele's hair, free of olivine phenocrysts, erupted during the early stages of the eruption; collected by H. Ikawa, Nov. 22, 1959. T. Katsura, analyst.
2. Surface of lava crust adjacent to Lawrence Radiation Laboratory drill hole. T. Katsura, analyst.
3. Core from drill hole at depth of 4 ft. T. Katsura, analyst.
4. Core from drill hole at depth of 7.5 ft. (picrite-basalt of oceanite type). T. Katsura, analyst.
5. Core from drill hole at depth of 7.7 ft. (picrite-basalt of oceanite type). T. Katsura, analyst.
6. Cuttings from drill hole in interval between 12 and 14 ft. depth. (No core was recovered.) T. Katsura, analyst.
7. Core from drill hole at depth of 13.9 ft. T. Katsura, analyst.
8. Core from drill hole at depth of 16.2 to 16.8 ft. T. Katsura, analyst.
9. Liquid lava from beneath crust. T. Katsura, analyst.
10. Liquid lava from beneath crust. T. Katsura, analyst.
11. Olivine phenocryst from picrite-basalt at depth of 7.5 ft. in drill hole. T. Katsura, analyst.

S-1. Olivine basalt lava poured onto floor of Kilauea Iki between November 14 and 21, 1959. J. H. Scoon, analyst. (Tilley, 1960: 494.)

S-2. Spatter thrown onto south rim of Kilauea Iki crater between November 18 and 21, 1959. J. H. Scoon, analyst. (Tilley, 1960: 494.)

type. It is believed to be the olivine-enriched lower part of the last lava to spread across the crater floor. No phenocrysts other than olivine are present in any of the samples. The groundmass is intergranular to intersertal, and consists of calcic plagioclase, averaging about An_{65}, monoclinic pyroxene, iron ore, and locally interstitial glass. The pyroxene ranges from augite with an optic axial angle of at least 50° to pigeonite with an angle close to 0°. No silica mineral was observed. Glass increases gradually in samples below 15 ft., suggesting that interstitial fluid in the rocks was chilled at the time of sampling.

Samples 9 and 10, the congealed liquid picked up in the end of the drill pipe, are much alike except for greater abundance of olivine phenocrysts in the former. Both consist predominantly of glass. Around the edge a zone 1–2 mm. thick consists of about 85 per cent pale brown glass with scattered microlites of feldspar, pyroxene, and magnetite. This appears to have resulted from quick chilling of the liquid against the steel pipe. The rest of the core consists of black to deep brown glass, containing phenocrysts of olivine up to 1.5 mm. long, and small grains of plagioclase and pyroxene, locally clotted together in glomeroporphyritic texture. The larger olivines have $(-)2V = 80°\pm$. They show moderate skeletal development, and little or no signs of resorption. The larger pyroxene grains are lime-poor augite, with $(+)2V = 50°\pm$. Some smaller grains have $(+)2V = 30°\pm$. Small grains of magnetite are present, and the dark color of the glass appears to result from very finely dispersed iron ore. The proportion of glass is variable, but averages 50–60 per cent.

All but one of the Kilauea Iki samples are quite definitely tholeiitic. The single exception is sample 10, which is transitional from the tholeiitic to the alkalic rocks. In Figure 2, in which total alkali content is plotted against silica, sample 10 lies just within the alkalic basalt field. On the basis of very quick inspection of the analyses, Dr. Kuno has suggested (oral communication, March 2, 1961) that sample 10 represents an iron- and alkali-enriched segregation similar to the veinlet from a flow in the wall of Kilauea caldera described by him and his associates (1957: 187). Indeed, in Figure 1 the point representing the iron-enriched segregation veinlet (F) lies directly on the trend of the Kilauea Iki rocks. However, the veinlet is distinctly poorer in alumina and richer in silica than Kilauea Iki sample 10, and lies well within the tholeiite field (Fig. 2). The similarity of Kilauea Iki sample 10 to typical alkalic basalts strongly suggests the possibility of derivation of the alkalic basalts in general from *undersaturated* tholeiitic magma.

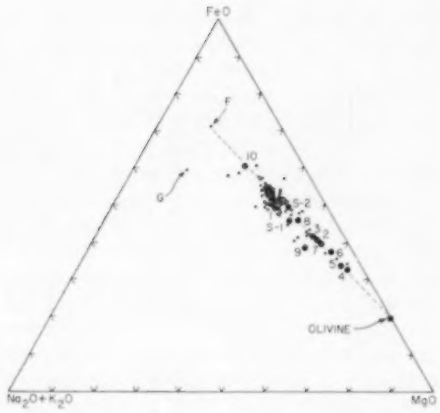

FIG. 1. Diagram of compositional variations in tholeiitic rocks of the Hawaiian Islands. Large dots represent the Kilauea Iki samples, the numbers corresponding with those in Table 1. Small dots represent other rocks. *F* represents the position of the iron-enriched segregation veinlet described by Kuno *et al.* (1957), and *G* indicates the position of the granophyre from Palolo Quarry, Honolulu, described by the same authors.

TABLE 1 (*Cont.*)

* Four careful determinations of each component in analysis 10 were made. The reproducibility (precision of measurement) is sufficient for the present purpose. Cu, Zn, V, Ba, Sr, Cr, Mo, W, and Pb were detected qualitatively by means of X-ray, but not in significant amounts, and cannot therefore be responsible for the low total in this analysis. The latter is the result of an appreciable amount of graphite in the analyzed sample, which was not soluble in mixed solutions of H_2SO_4 and HF or HNO_3 and HF. The graphite unquestionably came from the powdered graphite used to lubricate the joints of the drilling tools. The amounts of F, Cl, and C are being determined at the Tokyo Institute of Technology.

TABLE 2

COMPOSITIONS OF MATERIAL OBTAINED BY CALCULATION, ASSUMING VARIOUS AMOUNTS OF OLIVINE ADDED TO A PARENT MAGMA OF THE COMPOSITION OF THE PELE'S HAIR, COMPARED WITH COMPOSITIONS OBTAINED BY ACTUAL ANALYSIS OF KILAUEA IKI DRILL-HOLE SAMPLES

	SAMPLE 2		SAMPLE 3		SAMPLE 4		SAMPLE 5		SAMPLE 6		SAMPLE 7		SAMPLE 8		SAMPLE 9	
	Anal.	Calc.	Anal.	Calc.	Anal.	Calc.	Anal.	Calc.	Anal.	Calc.	Anal.	Calc.	Anal.	Calc.	Anal.	Calc.
SiO_2	46.8	47.4	47.0	47.5	44.6	45.1	45.6	45.5	45.6	46.4	47.2	47.1	48.3	48.3	48.4	48.8
Al_2O_3	12.0	11.5	12.1	11.6	9.3	8.6	9.1	9.0	10.6	10.3	11.1	11.2	12.9	12.6	13.0	13.4
CaO	9.9	9.6	9.9	9.7	7.2	7.0	7.8	7.6	8.4	8.5	9.6	9.4	10.4	10.6	10.0	11.3
Na_2O	1.8	1.9	1.8	1.9	1.4	1.4	1.2	1.5	1.5	1.7	1.5	1.9	2.0	2.1	2.1	2.3
K_2O	.4	.5	.5	.5	.3	.4	.3	.4	.4	.4	.4	.5	.5	.6	.6	.6
TiO_2	2.3	2.4	2.2	2.4	1.7	1.7	1.8	1.9	2.1	2.1	2.2	2.3	2.5	2.6	3.0	2.8
P_2O_5	.24	.20	.25	.21	.19	.15	.16	.16	.25	.18	.15	.20	.28	.23	.32	.24
Amount of olivine added (wt. per cent)	15		14		38		33		25		17		6		—1	

DIFFERENTIATION IN KILAUEA IKI LAVA

In Figure 1 the analyses of samples of Kilauea Iki lava are plotted on a standard AFM diagram, together with those of 85 other tholeiitic rocks of the Hawaiian Islands. The general tholeiitic trend of the Kilauea Iki samples is apparent.

The trends of both the Kilauea Iki rocks and of the tholeiitic rocks in general head directly toward the position of olivine (Fo_{80}) on the FeO-MgO join, and it is clear that compositional variations in the suite as a whole, including the Kilauea Iki rocks, can be accounted for largely by variations in the amount of olivine subtracted from, or added to, a parent magma with a composition lying along the same trend line.

Although movement of olivine was the main control in the differentiation, calculations indicate that minor amounts of other material also are involved. Column 2 of Table 3 shows the composition of the least amount of material that must be added to magma of the composition of the Pele's hair (Table 1, column 1) to produce a rock of the composition of the picrite-basalt from a depth of 7.5 ft. in the drill hole (Table 1, column 4). The material is preponderantly olivine, but includes also calcic plagioclase, pyroxene, and iron ore. The fact that the plagioclase is wholly anorthite indicates that some amount of material greater than the least possible actually has been added, since the first plagioclase to separate from a magma of the composition of the Pele's hair would have a more sodic composition (about An_{85}). The pyroxene also would be slightly poorer in Ca and increased in amount, but olivine would remain by far the most abundant component. Similar conclusions have been reached by Muir and Tilley (1957) regarding the 1840 picrite-basalt of Kilauea.

Similar results can be obtained by assuming a liquid phase of constant chemical composition like that of the Pele's hair and adding to it arbitrary amounts of olivine of the composition of that in the picrite-basalt (Table 1, analysis 11). Table 2 shows the results of these calculations compared to the actual compositions determined by analysis. The lower line indicates the amount of olivine added in each case, calculated on the basis of the amount of MgO and FeO in both the olivine and the Pele's hair. Since this method of calculation of necessity results in identical values of FeO and MgO in the analyzed and calculated materials, the figures are insignificant in the present connection and are omitted from the table. Note that for the most part the calculated compositions are quite close to the actual ones, again indicating that the principal substance added during the differentiation was olivine. In the case of sample 9 the agreement is somewhat less good, especially in the CaO content, suggesting that other factors than the addition of olivine have been involved. It is impossible to calculate sample 10 on the same basis, because the amount of olivine becomes negative—that is, olivine must be removed from, not added to, the Pele's hair to yield sample 10.

The composition of the liquid phase of the magma during the beginning of the eruption is represented by the analysis of Pele's hair (Table 1, column 1). However, even at that time the bulk composition of the magma was somewhat more mafic, due to the presence of olivine phenocrysts and possibly other crystals not contained in the analyzed sample. This bulk composition is probably better represented by analyses S-1 or S-2. These in turn are less mafic than the average magma extruded later in the eruption. Richter and Eaton (1960) note a general tendency for the lava of late stages to be a little more mafic than that of the early stages. The best approximation to the composition of the "parent magma" for the suite of drill-hole samples may therefore be an average of analyses 2 and 3. This average is given in column 1 of Table 3.

Whereas samples 4 to 7 are probably cumulative types, derived by addition to the parent magma of sinking crystals, largely olivine, samples 8 to 10 are probably residual magma from which crystals have been removed. In Figure 1 they lie along the same trend, but on the other side of the parent magma (samples 2 and 3) from the cumulative types. Their position on the same trend line suggests that they have been derived largely by the same general process as the other Kilauea Iki rocks and the tholeiitic rocks in general. However, in Figure 2 samples 9 and 10 lie along a line that deviates markedly from the general tholeiitic trend. Sample 10 in

TABLE 3

PROBABLE PARENT MAGMA AND MATERIAL ADDED TO OR SUBTRACTED FROM IT TO OBTAIN OTHER ROCKS

	1	2	3	4	5	6	7	8
SiO_2	46.9	40.6	51.4	49.2	49.0	45.4	45.1	40.5
Al_2O_3	12.9	5.0	9.1	12.9	13.2	10.7	9.2	8.0
Fe_2O_3	2.1	0.9	2.5	1.8	1.7	2.8	3.8	3.5
FeO	9.6	11.7	1.7	8.8	9.6	6.0	6.4	8.0
MgO	14.6	38.1	15.7	10.0	9.3	22.7	22.6	30.5
CaO	9.9	3.1	17.7	12.2	11.6	11.1	11.1	7.5
Na_2O	1.5	0.0	2.0	2.2	2.2	0.7	0.7	0.0
K_2O	0.4	0.0	0.0	0.5	0.6	0.0	0.0	0.0
TiO_2	2.3	0.6	0.0	2.3	2.6	0.6	0.6	1.5
NORMS								
ne	.....	.....	2.6	.....	.....	.....	.....	.....
or	2.2	.....	.....	2.8	3.3	.....	.....	.....
ab	12.6	.....	12.0	19.5	18.3	5.8	5.8	.....
an	27.2	13.6	15.8	23.9	24.5	26.1	22.0	21.7
di wo	8.8	0.7	30.0	15.0	13.5	12.1	13.5	6.5
di en	6.1	0.5	25.4	9.7	8.4	9.5	10.4	5.1
di fs	2.0	0.1	0.7	4.2	4.2	1.2	1.6	0.7
hy en	11.9	2.9	.....	7.0	8.5	5.9	7.5	3.5
hy fs	4.0	0.7	.....	3.2	4.4	0.8	1.1	0.4
ol fo	13.0	64.3	13.8	5.8	4.4	29.3	27.0	47.3
ol fa	5.0	14.5	0.4	3.0	2.8	4.3	4.1	6.3
mt	3.0	1.4	3.7	2.6	2.6	4.2	5.6	5.1
il	4.4	1.2	.....	4.4	5.0	1.2	1.2	2.9
plagioclase	An_{68}	.....	An_{57}	An_{55}	An_{57}	An_{82}	An_{79}	.....
Per cent wo in pyroxene	27	.....	53	38	35	41	39	40
Per cent of crystallization	.....	.....	50	75	90	25	50	17

1. Average of analyses 2 and 3, Table 1.
2. Least amount of material that added to Pele's hair (Table 1, analysis 1) yields the picrite-basalt (Table 1, analysis 4).
3. Least amount of material that subtracted from Pele's hair yields the composition of sample 10 (Table 1).
4. Material that subtracted from Pele's hair yields sample 10, assuming 75 per cent crystallization.
5. Material that subtracted from Pele's hair yields sample 10, assuming 90 per cent crystallization.
6. Least amount of material that subtracted from column 1 of this table yields sample 10.
7. Material that subtracted from column 1 yields sample 10, assuming 50 per cent crystallization.
8. Least amount of material that subtracted from column 1 yields sample 8 (Table 1).

particular differs greatly in alkali: silica ratio from typical tholeiitic rocks, containing half again as much alkali as rocks with the same silica content lying on the main trend line, such as sample 8.

If we assume that the liquid phase of the parent magma had the composition of the Pele's hair (Table 1, analysis 1), the composition of the material that must be removed from it by crystallization to yield magma of the composition of sample 10 can be calculated. Columns 3, 4, and 5 of Table 3 indicate the composition of the material, assuming respectively 50, 75, and 90 per cent crystallization of the parent liquid.

Column 3 appears to represent an impossible situation, because the plagioclase is considerably richer in sodium (Ab_{43}) than it should be (Ab_{30}) to have separated from the parent magma at that degree of crystallization. The same objection applies in lesser degree to

columns 4 and 5. Furthermore, if the conclusion that the pool of lava beneath the crust was largely liquid at the end of the eruption is correct, the thinness of the solid crust (less than 20 ft.) seems incompatible with degrees of crystallization of 90 or even 75 per cent. Also, in column 3 the pyroxene is considerably more calcic than would be expected to crystallize from a magma of the composition of the Pele's hair.

Columns 6 and 7 of Table 3 show the composition of material that would have to be separated from a parent magma of the average composition of analyses 2 and 3 (Table 1) to yield magma of the composition of sample 10, assuming about 25 and 50 per cent crystallization respectively. The mineral compositions indicated in the norms appear quite reasonable to have crystallized from magma of that composition. This appears to furnish further corroboration that samples 2 and 3 more nearly represent the parent magma of the drill-hole samples, and to indicate that sample 10 could have been derived from that parent wholly by crystal differentiation.

In Figure 2, as in Figure 1, samples 2 to 8 lie along a trend controlled largely by movement of olivine. The sharp divergence of samples 9 and 10 from that trend can be explained largely by the onset of more abundant crystallization of pyroxene. The position of the average tholeiitic pyroxene given by Kuno (1960: 128) is plotted on the lower boundary of Figure 2, and it will be seen that a trend line from sample 8 through samples 9 and 10 intersects the silica scale close to the pyroxene point. It will also be noted that the norms of columns 6 and 7 (Table 3) contain considerably more pyroxene than does that of column 8, which represents the material that must be separated from the same parent magma to yield sample 8. The derivation of the alkali-rich sample 10 by increased crystallization of pyroxene agrees with Murata's (1960) suggestion that crystallization of pyroxene is an important factor in the formation of the alkalic basalts.

Thus, it appears possible to derive all of the Kilauea Iki rocks by crystallization differentiation, and unquestionably this process has been of prime importance. This does not, however, prove that no other process has been involved.

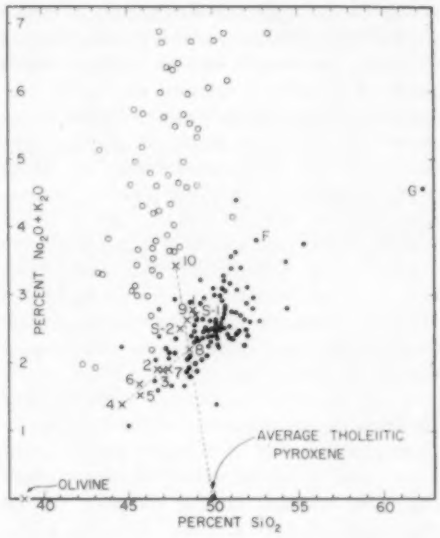

FIG. 2. Alkali : silica diagram of Hawaiian lavas. The compositions of the lavas of the 1959 eruption of Kilauea Iki are shown by crosses, those of rocks belonging to the tholeiitic suite by solid dots, and those of rocks of the alkalic suite by open circles. The point for olivine represents phenocrysts of that mineral in the 1959 lava; that for pyroxene is an average of tholeiitic pyroxenes listed by Kuno (1960: 128). The dashed line indicates the trend of differentiation of the Kilauea Iki drill-hole samples. *F* indicates the position of the iron-enriched segregation veinlet of Kilauea, and *G* that of the granophyre from Palolo Quarry (Kuno *et al.*, 1957).

Indeed, it would seem to be a foregone conclusion that other processes must have been going on in the magma and must have, to some degree, affected the composition of the magma. Such effects are most likely to have been appreciable in the rocks that depart from the main trend of differentiation, such as samples 9 and 10. The departure of these samples from the trend results principally from their greater richness in alkalies. The transfer and concentration of alkalies in one way or another as a part of magmatic differentiation has been suggested by many writers. It has thus far proved difficult to demonstrate to the satisfaction of petrologists in general, but this does not seem an adequate reason to omit it from consideration.

One of the suggested mechanisms by which alkalies may be concentrated is volatile transfer —volatile compounds moving upward toward points of gas escape, carrying alkalies in solution and releasing them because of pressure decrease at and near the top of the magma body. Another process is thermodiffusion, by which certain substances, including alkalies, migrate toward cooling surfaces (Wahl, 1946). Either or both of these may well have operated to some degree in the Kilauea Iki lava pool. Small amounts of gas have oozed from the surface of the pool constantly, ever since its formation. Likewise, the broad crusted surface of the pool exposed directly to the atmosphere and cooled by wind and frequent rains provides an ideal condition for the operation of thermodiffusion. These processes may be bringing about a gradual enrichment of the upper part of the liquid magma in alkalies. Further sampling of the congealing lava pool is highly desirable, to determine whether the trend observed in sample 10 is a continuing one.

Whether the divergence of Kilauea Iki sample 10 from the general tholeiitic trend offers a clue to the origin of the alkalic basalts cannot now be asserted. It is noteworthy, however, that it is closely similar to the transverse trend found by Tomkeieff (1937) in the Paleozoic basalts of Scotland.

CONCLUSIONS

The foregoing evidence: (1) Indicates the existence in Hawaii of completely liquid tholeiitic magma undersaturated in silica at least to the degree of containing nearly 10 per cent normative olivine; (2) confirms the dominance in the tholeiitic suite of crystal differentiation involving primarily the movement of magnesian olivine, with small amounts of pyroxene and calcic plagioclase; (3) indicates that at least marginal members of the alkalic suite can be derived from undersaturated tholeiitic magma; (4) suggests that this can be accomplished by crystallization differentiation controlled by the separation of pyroxene; but (5) leaves open the possibility of the operation of such other processes of differentiation as volatile transfer of alkalies and thermodiffusion.

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A Guide to the Literature and Distributions of Pacific Benthic Algae from Alaska to the Galapagos Islands

E. YALE DAWSON[1]

FIFTEEN YEARS AGO the writer prepared the first "Guide to the marine algae of Pacific North America" (Dawson, 1946*a*). That first check list of the benthic flora of the region has become outdated by the results of extensive explorations of the Mexican coasts and islands from 1946 to 1952, and, subsequently, of the coasts of Central America and British Columbia. Doty's "Marine algae of Oregon" (1947) appeared as the first treatment of that region, and a number of studies of California algae have added considerable literature for that area. The fuller knowledge of the Mexican and Central American algae has shown such affinities with the flora of the Galapagos Archipelago that it has seemed appropriate to include the entire northeast Pacific in the present list, from the southern boundary of Ecuador and the Galapagos Islands to the Aleutian Islands, and including Clipperton Island and the Revillagigedo Archipelago, but not extending as far west as Hawaii or the Line Islands, for which an independent account is intended.

As before, the literature cited represents the references that provide an adequate key to all previous literature dealing with the occurrence of a given species along the Pacific American coasts. Thus, some 80 titles have been added to bring this expanded list up to date, but one will find himself frequently referred to larger bibliographies such as those of Smith (1944), Taylor (1945), Scagel (1957), Dawson (1954*a*), and others, for earlier or more exhaustive citations of literature.

For the sake of consistency, the distribution records are cited from north to south.

The classification is essentially according to that of Papenfuss (1955).

[1] Beaudette Foundation for Biological Research, Solvang, California. Manuscript received May 16, 1960.

SYSTEMATIC LIST

PHYLUM CHLOROPHYCOPHYTA

ORDER VOLVOCALES

SUBORDER VOLVOCINEAE

FAM. POLYBLEPHARIDACEAE

Stephanoptera gracilis (Artari) G. M. Smith

Scagel, 1957
Northern Wash. to Monterey, Calif.

Dunaliella salina (Dunal) Teodoresco

Scagel, 1957
Northern Wash. to Monterey, Calif.

FAM. CHLAMYDOMONADACEAE

Platymonas subcordiformis (Wille) Hazen

Smith, 1944
Monterey, Calif.

SUBORDER CHLORODENDRINEAE

FAM. CHLORANGIACEAE

Collinsiella tuberculata Setchell & Gardner

Scagel, 1957
Southern British Columbia to Pacific Grove, Calif.

Prasinocladus ascus Proskauer

Proskauer, 1950
Near Santa Cruz, Calif.

Prasinocladus lubricus Kuckuck

Proskauer, 1950; Scagel, 1957
Friday Harbor, Wash., to Monterey, Calif.

ORDER ULOTRICHALES

FAM. ULOTRICHACEAE

Ulothrix flacca (Dillwyn) Thuret, in Le Jolis

Scagel, 1957
St. Michael, Alaska, to Calif.

Ulothrix implexa Kützing

Scagel, 1957
Bering Sea to Monterey, Calif.

Ulothrix laetevirens (Kützing) Collins

Scagel, 1957
Unalaska, Alaska, to Calif.

Ulothrix pseudoflacca f. *minor* Wille

Setchell & Gardner, 1920
Sitka, Alaska

Ulothrix pseudoflacca f. *major* Wille

Setchell & Gardner, 1920
San Francisco, Calif.

Ulothrix pseudoflacca f. *maxima* Setchell & Gardner

Setchell & Gardner, 1920
San Francisco, Calif.

Ulothrix zonata (Weber & Mohr) Kützing

Doty, 1947
Harris State Park; Squaw Creek, Oreg.

Hormidium rivulare Kützing

Doty, 1947
Winchester Bay, Oreg.

FAM. CHAETOPHORACEAE

Bolbocoleon piliferem Pringsheim

Setchell & Gardner, 1920; Dawson, 1945*b*
Southern Calif.

Pilinia lunatiae f. *simplex* Thivy

Taylor, 1945
Panama City, Panama

Pilinia maritima f. *pacifica* Thivy

Taylor, 1945; Dawson, 1954
Isla Clarión, Revillagigedo Arch.; Galapagos Arch.

Phaeophila dendroides (Crouan) Batters

Dawson, 1954
Isla María Magdalena, Nayarit

Phaeophila engleri Reinke

Taylor, 1945; Dawson, 1954
Isla Clarión, Revillagigedo Arch., to Isla Taboga, Panamá; Galapagos Arch.

Phaeophila polymorpha Jao

Scagel, 1957
Northern Wash.

Ectochaete perforans Thivy

Taylor, 1945
Galapagos Arch.

Zygomitus reticulatus Bornet & Flahault

Taylor, 1945
Galapagos Arch.

Entocladia cingens Setchell & Gardner

Setchell & Gardner, 1920
San Diego, Calif.

Entocladia codicola Setchell & Gardner

Smith, 1944; Dawson, 1945*b*
Monterey Peninsula to La Jolla, Calif.

Entocladia condensata Setchell & Gardner

Dawson, 1954
Puerto Libertad; Isla San Esteban, Gulf of Calif.

Entocladia mexicana Setchell & Gardner

Dawson, 1954
Isla Ángel de la Guarda; La Paz, Gulf of Calif.

Entocladia polysiphoniae Setchell & Gardner

Dawson, 1954; Dawson, 1957 (as probably identical with *E. viridis*)
Guaymas; La Paz, Gulf of Calif.

Entocladia viridis Reinke

Scagel, 1957; Dawson, 1957
Southern British Columbia to Monterey, Calif.; Galapagos Arch.

Endophyton ramosum Gardner

Doty, 1947
Brookings, Oreg., to Monterey Peninsula, Calif.

Pseudodictyon geniculatum Gardner

Doty, 1947
Sunset Bay, Oreg., to Pacific Grove, Calif.

Internoretia freyeana Setchell & Gardner

Scagel, 1957
Friday Harbor, Wash.

Ulvella setchellii Dangeard

Smith, 1944; Hollenberg, 1948; Dawson, 1954
Pacific Grove, Calif., to Isla Guadalupe, Baja Calif.

Pseudulvella applanata Setchell & Gardner

Smith, 1944
Carmel, Calif.

Pseudulvella consociata Setchell & Gardner

Doty, 1947
South Bay, Oreg.; Alameda, Calif.

Pseudulvella prostrata (Gardner) Setchell & Gardner

Setchell & Gardner, 1920
San Francisco, Calif.

Pseudopringsheimia apiculata Setchell & Gardner

Smith, 1944
San Francisco; Monterey, Calif.

Pringsheimiella marchantae (Setchell & Gardner) Schmidt

Schmidt, 1935; Dawson, 1954
La Paz, Baja Calif.

Pringsheimiella scutata (Reinke) Schmidt & Petrack, in Schmidt

Dawson, 1960*a*
Isla Guadalupe, Baja Calif.

FAM. TRENTEPOHLIACEAE

Trentepholia odorata var. *umbrina* (Kützing) Hariot

Setchell & Gardner, 1920
San Pedro, Calif.

FAM. MONOSTROMACEAE

Monostroma areolatum Setchell & Gardner

Setchell & Gardner, 1920
Sitka, Alaska

Monostroma dactyliferum Taylor

Taylor, 1945
Guayas, Ecuador

Monostroma ecuadoreanum Taylor

Taylor, 1945; Dawson, 1957*b*
Golfo Dulce, Costa Rica?; Guayas, Ecuador

Monostroma fractum Jao

Scagel, 1957
Turn I., Wash.

Monostroma fuscum (Postels & Ruprecht) Wittrock var. *fuscum*

Scagel, 1957
Kukak Bay, Alaska, to northern Wash.

Monostroma fuscum var. *blyttii* (Areschoug) Collins

Scagel, 1957
Southern British Columbia to northern Wash.

Monostroma fuscum var. *splendens* (Ruprecht) Rosenvinge

Scagel, 1957
St. Paul I., Alaska, to southern British Columbia

Monostroma grevillei (Thuret) Wittrock var. *grevillei*

Setchell & Gardner, 1920
Unalaska, Alaska

Monostroma grevillei var. *lubricum* (Kjellman) Collins
Setchell & Gardner, 1920
Sitka, Alaska

Monostroma grevillei var. *vahlii* (J. Agardh) Rosenvinge
Setchell & Gardner, 1920; Okamura, 1933
Aleutian Islands to Sitka, Alaska

Monostroma orbiculatum Thuret
Setchell & Gardner, 1920
Central Calif.

Monostroma oxyspermum (Kützing) Doty
Scagel, 1957
Southern British Columbia to southern Calif.

Monostroma zostericola Tilden
Scagel, 1957
Southern British Columbia to Monterey, Calif.

Blidingia minima (Nägeli) Kylin var. *minima*
Scagel, 1957; Dawson, 1959*c* (as *Enteromorpha minima*)
Dutch Harbor, Alaska, to Mexico

Blidingia minima var. *subsalsa* (Kjellman) Scagel
Scagel, 1957
Skagway, Alaska, to Chetco Cove, Oreg.

FAM. ULVACEAE

Enteromorpha acanthophora Kützing
Dawson, 1949*a*, 1954; Dawson, Neushul, Wildman, 1960*a*
Bahía Tortuga, Baja Calif.; Gulf of Calif.

Enteromorpha ahlneriana Bliding
Doty, 1947
North Bend, Oreg.

Enteromorpha clathrata (Roth) Greville
Dawson, 1954 (as *E. plumosa*); Scagel, 1957; Dawson, 1959, 1959*b*
Valdez, Alaska, to Carmel, Calif.; Isla Clarión, Revillagigedo Arch.; southern Gulf of Calif.; Clipperton I.

Enteromorpha compressa (Linnaeus) Greville
Dawson, 1949*a*, 1954; Scagel, 1957; Dawson, 1957*b*, 1959, 1959*c*
Bering Sea to Costa Rica

Enteromorpha crinita (Roth) J. Agardh
Taylor, 1945; Dawson, 1959*c*
Valdes, Alaska, to San Diego, Calif.; Galapagos Arch.

Enteromorpha groenlandica (J. Agardh) Setchell & Gardner
Setchell & Gardner, 1920
Bering Sea to Unalaska, Alaska

Enteromorpha intestinalis (Linnaeus) Link f. *intestinalis*
Okamura, 1933; Scagel, 1957; Dawson, 1957*c*
Kukak Bay, Alaska, to La Paz, Baja Calif.; Gulf of Calif.

Enteromorpha intestinalis f. *cylindracea* J. Agardh
Scagel, 1957
Popof I., Alaska, to Mexico

Enteromorpha intestinalis f. *maxima* J. Agardh
Scagel, 1957
Kukak Bay, Alaska, to Mexico

Enteromorpha intestinalis f. *clavata* J. Agardh
Scagel, 1957
Kukak Bay, Alaska, to Mexico

Enteromorpha lingulata J. Agardh
Dawson, 1954, 1957*b*; Taylor, 1945
Isla Guadalupe, Baja Calif., to Balboa, Canal Zone; Galapagos Arch.

Enteromorpha linza (Linnaeus) J. Agardh
Dawson, 1954; Scagel, 1957; Dawson, 1959*c* (as *Ulva linza*)
Orca, Alaska, to Mexico

Enteromorpha marginata J. Agardh
Scagel, 1957
Vancouver I., British Columbia, to Calif.

Enteromorpha prolifera (Müller) J. Agardh var. *prolifera*

Dawson, 1954; Scagel, 1957
Golovnin Bay, Alaska, to Central America

Enteromorpha prolifera var. *flexuosa* (Wulfen) Doty

Doty, 1947; Setchell & Gardner, 1920 (as *E. flexuosa*); Taylor, 1945 (as *E. flexuosa*)
Santa Barbara, Calif., to Puerto Parker, Costa Rica; Guayas, Ecuador

Enteromorpha salina var. *polyclados* Kützing

Taylor, 1945
San Franciso Bay, Calif.; Galapagos Arch.

Enteromorpha torta (Mertens) Reinbold

Scagel, 1957
Southern British Columbia and Wash.; San Diego, Calif.

Enteromorpha tubulosa (Kützing) Kützing

Taylor, 1945; Dawson, 1954; Scagel, 1957
Northern Wash. to Cabo Colnett, Baja Calif.; Galapagos Arch.

Ulva angusta Setchell & Gardner

Smith, 1944; Dawson, 1954 (as *U. taeniata* and as *Enteromorpha angusta*), 1959*c*; Doty, 1947 (as *Enteromorpha angusta*)
Oreg. to southern Calif.; Isla Guadalupe, Baja Calif.?; Guaymas, Sonora

Ulva californica Wille

Doty, 1947; Dawson, 1959*c*, 1960*a*
Oreg.; Moss Beach, Calif.; southern Calif.; Isla Magdalena, Baja Calif.

Ulva dactylifera Setchell & Gardner

Taylor, 1945; Dawson, 1954, 1959
Southern Calif. to San Roque, Baja Calif.; southern Gulf of Calif.; Guayas, Ecuador ?; Galapagos Arch.?

Ulva expansa (Setchell) Setchell & Gardner

Dawson, 1954; Scagel, 1957
Southern British Columbia to Monterey, Calif.; La Paz, Baja Calif.?

Ulva fasciata Delile

Farlow, 1902; Taylor, 1945
Galapagos Arch.

Ulva fenestrata Postels & Ruprecht

Scagel, 1957
Sitka, Alaska, to Oreg.

Ulva lactuca Linnaeus

Taylor, 1945; Dawson, 1954; Scagel, 1957; Dawson, 1959, 1959*c*
Bering Sea to Guayas, Ecuador; Galapagos Arch.

Ulva latissima Linnaeus

Scagel, 1957
Juneau, Alaska, to northern Wash.

Ulva lobata (Kützing) Setchell & Gardner

Taylor, 1945; Doty, 1947; Dawson, 1954, 1957, 1959*b*, 1959*c*
Oreg. to San Diego, Calif.; Bahía Petatlán, Guerrero; Clipperton I.; Guayas, Ecuador; Galapagos Arch.

Ulva rigida C. Agardh

Dawson, 1949*a*; Scagel, 1957; Dawson, 1954, 1959*c*
Uyak Bay, Alaska, to La Paz, Baja Calif.; Gulf of Calif.

Ulva spinulosa Okamura & Segawa

Dawson, 1960*a*
Puerto Guatulco, Oaxaca

Ulva stenophylla Setchell & Gardner

Doty, 1947
Chetco Cove, Oreg. to Big Sur, Calif.

Ulva taeniata (Setchell) Setchell & Gardner

Doty, 1947; Dawson, 1954, 1959*c*
Coos Bay, Oreg., to Point Conception, Calif. (more southern records are probably all *U. angusta*)

Ulva vexata Setchell & Gardner

Doty, 1947 (as *Enteromorpha vexata*)
Oreg.; San Francisco, Calif.

Percursaria percursa (C. Agardh) Rosenvinge
Scagel, 1957
Amaknak I., Alaska, to San Francisco Bay, Calif.

ORDER SCHIZOGONIALES

FAM. PRASIOLACEAE

Schizogonium murale f. *uniseriatum* Jao
Scagel, 1957
Dinner Point, Wash.

Prasiola borealis Reed
Setchell & Gardner, 1920
Unalaska, Kodiak, and Baranof islands, Alaska

Prasiola calophylla (Carmichael) Meneghini
Scagel, 1957
Whidbey I., Wash.

Prasiola delicatula Setchell & Gardner
Setchell & Gardner, 1920
Sitka, Alaska

Prasiola linearis Jao
Scagel, 1957
Argyle Lagoon, Wash.

Prasiola meridionalis Setchell & Gardner
Scagel, 1957; Silva, 1957
Friday Harbor, Wash., to Carmel, Calif.; Santa Cruz I., Calif.

Rosenvingiella constricta (Setchell & Gardner) Silva
Silva, 1957; Scagel, 1957
Friday Harbor, Wash.; Tomales Point; Monterey; Santa Cruz I., Calif.

Rosenvingiella polyrhiza (Rosenvinge) Silva
Silva, 1957
Amaknak I., Alaska

ORDER CHLOROCOCCALES

FAM. CHLOROCOCCACEAE

Chlorochytrium inclusum Kjellman
Scagel, 1957
Sitka, Alaska, to Camel, Calif.

Chlorochytrium porphyrae Setchell & Gardner
Scagel, 1957
Cape Flattery, Wash.; San Francisco; Monterey Peninsula, Calif.

Chlorochytrium schmitzii Rosenvinge
Setchell & Gardner, 1920
Kodiak I., Alaska

Codiolum penicilliforme (Roth) Silva
Scagel, 1957 (as *Codiolum gregarium*); Silva, 1957*a* (as the sporophyte generation of *Urospora penicilliformis*)
Southern British Columbia to northern Wash.

Codiolum petrocelidis Kuckuck
Scagel, 1957; Fan, 1959 (Fan, and also Hollenberg, 1958, indicate this as the sporophyte generation of *Spongomorpha coalita*)
Northern Wash. to Monterey, Calif.

Codiolum pusillum f. *subsessile* Jao
Scagel, 1957
Brown I., Wash.

FAM. GOMONTIACEAE

Gomontia polyrhiza (Lagerheim) Bornet & Flahault
Scagel, 1957
Neah Bay, Wash., to Monterey, Calif.

ORDER CLADOPHORALES

FAM. CLADOPHORACEAE

Rhizoclonium crassipellitum var. *robustum* G. S. West
Taylor, 1945
Galapagos Arch.

Rhizoclonium implexum (Dillwyn) Kützing
Taylor, 1945 (as *R. riparium* var. *implexum*); Scagel, 1957
St. Michael I., Alaska, to Carmel, Calif.; Galapagos Arch.

Rhizoclonium kerneri Stockmayer
Dawson, 1959; Scagel, 1957
Victoria, British Columbia

Rhizoclonium kochianum Kützing

Taylor, 1945 (as *R. kerneri*); Dawson, 1959, 1960*a*
Puerto Escondido, Gulf of Calif.; Isla Clarión, Revillagigedo Arch.; Isla Jicarón, Panamá

Rhizoclonium rhizophilum Taylor

Taylor, 1945
Galapagos Arch.

Rhizoclonium riparium (Roth) Harvey

Scagel, 1957
Unalaska, Alaska, to southern Calif.; Galapagos Arch.

Rhizoclonium tortuosum (Dillwyn) Kützing

Scagel, 1957
Kodiak Bay, Alaska, to Carmel, Calif.

Lola lubrica (Setchell & Gardner) A. & G. Hamel

Dawson, 1954; Scagel, 1957
Northern Wash. to Puerto Culebra, Costa Rica

Urospora doliifera (Setchell & Gardner) Doty

Doty, 1947
Chetco Cove, Oreg.; San Francisco, Calif.

Urospora grandis Kylin

Scagel, 1957
Unalaska, Alaska, to Oreg.

Urospora penicilliformis (Roth) Areschoug

Dawson, 1949 (as *Chaetomorpha catalinae*); Dawson, 1954*d*; Scagel, 1957; Silva (1957*a*) treats this as *Codiolum penicilliformis*, the alternate, gametophyte generation of *Codiolum gregarium*
Bering Sea to southern Calif.

Urospora sphaerulifera (Setchell & Gardner) Scagel

Scagel, 1957
Whidbey I., Wash.

Urospora tetraciliata (Frye & Zeller) Scagel

Scagel, 1957
San Juan County, Wash.

Urospora vancouveriana (Tilden) Scagel

Scagel, 1957
Oak Bay, Vancouver I., British Columbia

Urospora wormskioldii (Mertens) Rosenvinge

Scagel, 1957
Southern British Columbia to Gualala, Calif.

Chaetomorpha aerea (Dillwyn) Kützing

Dawson, 1954, 1959*c*
Santa Cruz to San Diego, Calif.; northern Gulf of Calif.

Chaetomorpha antennina (Bory) Kützing

Dawson, 1945*b*, 1954, 1954*c*, 1959, 1959*b*; Dawson & Beaudette, 1960
La Jolla, Calif., to Guayas, Ecuador; Clipperton I.; Galapagos Arch.

Chaetomorpha atrovirens Taylor, approx.

Dawson, 1954
Isla Guadalupe

Chaetomorpha bangioides Dawson

Dawson, 1954, 1959
Isla Patos; Puerto Escondido, Gulf of Calif.

Chaetomorpha brachygona var. *crassipellita* Taylor

Taylor, 1945
Galapagos Arch.

Chaetomorpha californica Collins

Setchell & Gardner, 1920
Laguna Beach to La Jolla, Calif.

Chaetomorpha cannabina (Areschoug) Kjellman

Scagel, 1957
Norton Sound, Alaska, to Puget Sound, Wash.

Chaetomorpha clavata (C. Agardh) Kützing

Dawson, 1954
Punta Descanso; Cabo Colnett, Baja Calif.

Chaetomorpha crassa (C. Agardh) Kützing

Dawson, 1954
Islas San Benitos; Bahía Magdalena, Baja Calif.

Chaetomorpha exposita (Børgesen) Dawson

Dawson, 1954*c*
Isla San Benedicto, Revillagigedo Arch.

Chaetomorpha gracilis Kützing

Dawson, 1954*c*
Isla San Benedicto, Revillagigedo Arch.

Chaetomorpha indica Kützing

Dawson, 1960*a*
Isla del Rey, Panamá

Chaetomorpha linoides (C. Agardh) Kützing

Dawson, 1954
Cabo San Lucas, Baja Calif.; Mazatlán, Sinaloa

Chaetomorpha linum (Müller) Kützing

Dawson, 1954; Taylor, 1945; Dawson, 1959
Isla Cedros, Baja Calif.; Isla Carmén, Gulf of Calif.; Galapagos Arch.

Chaetomorpha melagonium (Weber & Mohr) Kützing

Setchell & Gardner, 1920; Okamura, 1933
Aleutian Islands to Kodiak I., Alaska

Chaetomorpha pachynema Montagne

Dawson, 1954
Punta Palmilla, Baja Calif.

Chaetomorpha tenuissima Jao

Scagel, 1957
Northern Wash.

Chaetomorpha torta (Farlow) McClatchie

Setchell & Gardner, 1920; Dawson, 1945*b*, 1949*a*, 1954, 1959*c*; Dawson, Neushul, Wildman, 1960
Southern Calif. to Isla Magdalena, Baja Calif.

Cladophora albida (Hudson) Kützing

Scagel, 1957; Dawson, 1954, 1959, 1960*a*
Southern British Columbia to northern Wash.; San Pedro, Calif.; Gulf of Calif.; Isla Grande, Guerrero

Cladophora amphibia Collins

Setchell & Gardner, 1920
San Francisco Bay, Calif.

Cladophora bertolonii var. *hamosa* (Kützing) Ardissone

Smith, 1944
Pacific Grove, Calif.

Cladophora crystallina (Roth) Kützing

Dawson, 1960*a*
Bahía Culebra, Costa Rica

Cladophora delicatula Montagne

Doty, 1947; Dawson, 1954
Oreg. to San Diego, Calif.; Rio Mayo, Sonora

Cladophora elmorei Dawson

Dawson, 1949
San Clemente Island, Calif.

Cladophora flexuosa (Griffiths) Harvey

Scagel, 1957
Annettee I., Alaska, to San Diego, Calif.

Cladophora glaucescens (Griffiths) Harvey

Scagel, 1957
Nanaimo, British Columbia, to Oakland, Calif.

Cladophora gracilis (Griffiths) Kützing f. *gracilis*

Scagel, 1957
Sitka, Alaska; Neah Bay, Wash.

Cladophora gracilis f. *expansa* Farlow

Dawson, 1954
Isla Clarión, Revillagigedo Arch.

Cladophora graminea Collins

Smith, 1944; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Santa Cruz, Calif., to Isla Magdalena, Baja Calif.; Guaymas, Sonora

Cladophora hemispherica Gardner

Doty, 1947; Smith, 1944; Dawson, 1959*c*
Oreg. to northern Los Angeles Co., Calif.

Cladophora hesperia Setchell & Gardner

Dawson, 1954, 1954*d*
Vicinity of Isla Cedros, Baja Calif.; Kino, Sonora, to Mazatlán, Sinaloa

Cladophora hutchinsiae (Dillwyn) Kützing var. *hutchinsiae*

Scagel, 1957
Vancouver I., British Columbia

Cladophora hutchinsiae var. *distans* (C. Agardh) Kützing

Scagel, 1957
Southern British Columbia

Cladophora inserta Dickie f.

Dawson, 1957
Isla San Benedicto, Revillagigedo Arch.

Cladophora laetevirens (Dillwyn) Kützing

Scagel, 1957
Vancouver, British Columbia, and Straits of Juan de Fuca, Wash.

Cladophora macdougalii Howe

Dawson, 1954
Bahía San Felipe, Gulf of Calif.

Cladophora magdalenae Harvey

Dawson, 1954
Scammon Lagoon, Baja Calif.

Cladophora microcladioides Collins f. *microcladioides*

Dawson, 1954; Scagel, 1957; Dawson, 1959*c*
Southern British Columbia to Bahía Viscaino, Baja Calif.; Gulf of Calif.

Cladophora microcladioides f. *stricta* Collins

Setchell & Gardner, 1920
San Diego, Calif.

Cladophora ovoidea Kützing

Smith, 1944
Santa Cruz to Monterey, Calif.

Cladophora panamensis Taylor

Taylor, 1945
Bahía Honda, Panamá

Cladophora perpusilla Skottsberg & Levring

Dawson, 1954*c*, 1957, 1959*b*, 1960*a*
Isla San Benedicto, Revillagigedo Arch.; Puerto Guatulco, Oaxaca; Clipperton I.; Galapagos Arch.

Cladophora prolifera (Roth) Kützing

Taylor, 1945; Dawson, 1954, 1957*b*
Scammon Lagoon, Baja Calif.; Costa Rica; Guayas, Ecuador; Galapagos Arch.

Cladophora rudolphiana (C. Agardh) Kützing f. *rudolphiana*

Dawson, 1954, 1957*b*
Guaymas, Sonora; Golfo de Nicoya, Costa Rica

Cladophora rudolphiana f. *eramosa* Gardner

Setchell & Gardner, 1920; Dawson, 1954
San Francisco Bay, Calif.; Guaymas, Sonora

Cladophora socialis Kützing

Dawson, 1957*b*, 1959*b*
Golfo de Nicoya, Costa Rica; Clipperton I.

Cladophora stimpsonii Harvey

Scagel, 1957
Southern British Columbia to southern Calif.

Cladophora tiburonensis Dawson

Dawson, 1954
Isla Tiburón, Gulf of Calif.; Mazatlán, Sinaloa

Cladophora trichotoma (C. Agardh) Kützing f. *trichotoma*

Dawson, 1954; Scagel, 1957; Dawson, 1959*c*
Southern British Columbia to Isla Cedros, Baja Calif.; La Paz, Gulf of Calif. ?

Cladophora trichotoma f. *elongata* Collins

Setchell & Gardner, 1920
Point Carmel, Calif.

Cladophora utriculosa Kützing

Dawson, 1959, 1960*a*
Isla San Francisco, Gulf of Calif.; Bahía Chacahua, Oaxaca; Bahía Potrero Grande, Costa Rica

Spongomorpha arcta (Dillwyn) Kützing

Scagel, 1957
Bering Sea to Puget Sound, Wash.

Spongomorpha coalita (Ruprecht) Collins

Scagel, 1957; Fan, 1959 (Note: Hollenberg, 1958, and Fan, 1959, show this to be the gametophyte generation of *Codiolum petrocelidis*)
Unalaska, Alaska, to Carmel, Calif.

Spongomorpha conjuncta Taylor

Taylor, 1945
Galapagos Arch.

Spongomorpha duriuscula (Ruprecht) Collins

Okamura, 1933; Doty, 1947
Aleutian Islands to Karluk, Alaska; Oreg.

Spongomorpha hystrix Stroemfelt

Setchell & Gardner, 1920; Okamura, 1933
Agattu I. to Sitka, Alaska

Spongomorpha mertensii (Ruprecht) Setchell & Gardner

Scagel, 1957
Unalaska, Alaska, to San Francisco, Calif.

Spongomorpha saxatilis (Ruprecht) Collins var. *saxatilis*

Doty, 1947
Alaska to San Francisco, Calif.

Spongomorpha saxatilis var. *chamissonis* (Ruprecht) Collins

Scagel, 1957
Unalaska, Alaska, to Wash.

Spongomorpha spinescens Kützing

Scagel, 1957
Unalaska, Alaska, to Coos Bay, Oreg.

FAM. ANADYOMENACEAE

Valoniopsis hancockii Dawson

Dawson, 1954
Isla Ángel de la Guarda, Gulf of Calif.

Valoniopsis pachynema (Martens) Børgesen

Dawson, 1954, 1959
Scammon Lagoon, Baja Calif.; Isla Ángel de la Guarda to Isla Espíritu Santo, Gulf of Calif.; Isla Isabel, Nayarit

Microdictyon palmeri Setchell

Dawson, 1954
Isla Guadalupe, Baja Calif.

ORDER SIPHONOCLADALES

FAM. VALONIACEAE

Dictyosphaeria australis Setchell

Dawson, 1954
Cabeza Ballena, Baja Calif.; Isla Clarión, Revillagigedo Arch.

Dictyosphaeria versluysii Weber van Bosse

Dawson, 1954, 1954*c*
Isla Guadalupe, Baja Calif.; Isla Espíritu Santo, Gulf of Calif.; Revillagigedo Arch.

FAM. SIPHONOCLADACEAE

Siphonocladus pusilloides Setchell & Gardner

Dawson, 1954
Isla Guadalupe, Baja Calif.

Ernodesmis verticillata (Kützing) Børgesen

Dawson, 1954, 1959
Cabeza Ballena, Baja Calif. del Sur; Isla Carmén; La Paz, Gulf of Calif.

Cladophoropsis fasciculata (Kjellman) Børgesen

Dawson, 1958, 1959*c*
Lechuza Point; Dana Point, Calif.

Cladophoropsis gracillima Dawson

Dawson, 1954, 1957*b*, 1960*a*
Punta Palmilla, Baja Calif.; Costa Rica

Cladophoropsis membranacea (C. Agardh) Børgesen

Dawson, 1960*a* (*"Cladophora"* by error)
Punta Cono, Baja Calif.

Cladophoropsis (?) *robusta* Setchell & Gardner

Dawson, 1954 (as *Willeella mexicana* in part), 1957*b* (as *Willeella mexicana*), 1959
Southern Gulf of Calif.

FAM. BOODLEACEAE

Struvea anastomosans (Harvey) Piccone
Dawson, 1954, 1957*b*
Acapulco, Guerrero; Costa Rica

Boodlea composita (Harvey & Hooker, f.) Brand
Taylor, 1945; Dawson, 1954
Isla María Magdalena, Nayarit; Guayas, Ecuador

Boodlea siamensis Reinbold
Dawson, 1957*b*
Golfo Dulce, Costa Rica

ORDER SIPHONALES

FAM. DERBESIACEAE

Halicystis ovalis (Lyngbye) Areschoug
Scagel, 1957; Dawson, Neushul, Wildman, 1960, 1960*a* (Note: this is generally recognized as the gametophyte phase of *Derbesia marina*)
Silver Bay, Alaska, to Punta Eugenio, Baja Calif.

Derbesia attenuata Dawson
Dawson, 1959*b*, 1960*a*
Clipperton I.; Isla Brincanco, Panamá

Derbesia hollenbergii Taylor
Taylor, 1945; Dawson, 1959
Isla Carmén, Gulf of Calif.; Galapagos Arch.

Derbesia lamourouxii (J. Agardh) Solier
Dawson, 1954
Near Tijuana; Cabo Colnett, Baja Calif.

Derbesia longifructa Taylor
Taylor, 1945
Guayas, Ecuador

Derbesia marina (Lyngbye) Kjellman
Scagel, 1957 (Note: this is generally recognized as the sporophyte phase of *Halicystis ovalis*)
Sitka, Alaska, to La Jolla, Calif.

Derbesia pacifica Jao
Scagel, 1957
Turn I., Wash.

Derbesia prolifica Taylor
Taylor, 1945
Galapagos Arch.

Derbesia tenuissima (De Notaris) Crouan & Crouan ?
Dawson, 1954
Campo Malarrimo, Bahia Vizcaino, Baja Calif.

Derbesia vaucheriaeformis (Harvey) J. Agardh
Scagel, 1957
Yakutat Bay, Alaska, to northern Wash.

FAM. CAULERPACEAE

Caulerpa cupressoides var. *lycopodium* near f. *elegans* Weber van Bosse
Taylor, 1945
Isla Gorgona, Colombia

Caulerpa pinnata f. *pectinata* (Kützing) Weber van Bosse
Dawson, 1954
Isla Ángel de la Guarda, Gulf of Calif.

Caulerpa racemosa var. *clavifera* f. *macrophysa* (Kützing) Weber van Bosse
Dawson, 1954
Isla Guadalupe, Baja Calif.

Caulerpa racemosa var. *laetevirens* (Montagne) Weber van Bosse f. *laetevirens*
Dawson, 1954
Isla Guadalupe, Baja Calif.; Isla Clarión, Revillagigedo Arch.

Caulerpa racemosa var. *laetevirens* f. *cylindraceae* (Sonder) Weber van Bosse
Dawson, 1954
Isla Guadalupe, Baja Calif.; Clipperton I.

Caulerpa racemosa var. *occidentalis* (C. Agardh) Børgesen
Taylor, 1945; Dawson, 1954
Isla Clarión, Revillagigedo Arch.; Galapagos Arch.

Caulerpa racemosa var. *turbinata* (J. Agardh) Eubank

Dawson, 1954, 1959
Southern Gulf of Calif. to Mazatlán, Sinaloa

Caulerpa racemosa var. *uvifera* (Turner) Weber van Bosse

Dawson, 1954; Taylor, 1945
Isla Espíritu Santo, Gulf of Calif.; Galapagos Arch.

Caulerpa sertularioides (Gmelin) Howe

Dawson, 1954, 1959
Puerto Escondido to La Paz, Gulf of Calif.; Tangola-Tangola, Oaxaca

Caulerpa vanbosseae Setchell & Gardner

Dawson, 1954, 1959; Dawson, Neushul, Wildman, 1960*a*
Vicinity of Bahía Magdalena, Baja Calif.; Isla Ángel de la Guarda to Isla Espíritu Santo, Gulf of Calif.

FAM. BRYOPSIDACEAE

Pseudobryopsis hainanensis Tseng

Dawson, 1954*c*
Isla San Benedicto, Revillagigedo Arch.

Bryopsis corticulans Setchell

Dawson, 1954; Scagel, 1957; Dawson, 1959*c*
Southern British Columbia to La Jolla, Calif.; Islas San Benitos, Baja Calif.

Bryopsis galapagensis Taylor

Taylor, 1945; Dawson, 1954
Revillagigedo Arch.; Galapagos Arch.; Isla Gorgona, Colombia

Bryopsis hypnoides Lamouroux

Dawson, 1954; Scagel, 1957; Dawson, 1959*c*
Southern British Columbia to San Pedro, Calif.; La Paz, Gulf of Calif.; Panama City, Panamá

Bryopsis muscosa Lamouroux

Dawson, 1954, 1959
Pacific Baja Calif.; southern Gulf of Calif.; Salina Cruz, Oaxaca

Bryopsis pennata Lamouroux

Dawson, 1954 (as *B. pennatula* and as *B. plumosa* var. *pennata*), 1957*b*, 1959
Isla Tiburón, Gulf of Calif., to Golfo de Nicoya, Costa Rica

Bryopsis pennatula J. Agardh

Taylor, 1945; Dawson, 1954 (Note: probably equal to *B. pennata* according to Dawson, 1959)
Guerrero; Oaxaca; Galapagos Arch.

Bryopsis plumosa (Hudson) C. Agardh

Scagel, 1957
Southern British Columbia to northern Wash.

FAM. CODIACEAE

Boodleopsis verticillata Dawson

Dawson, 1960*a*
Isla del Rey, Panamá

Chlorodesmis hildebrandtii A. Gepp & E. Gepp

Dawson, 1957*b*, 1959
Southern Gulf of Calif.; Costa Rica

Chlorodesmis mexicana Taylor

Taylor, 1945; Dawson, 1954
Isla Guadalupe, Baja Calif., to Tangola-Tangola, Oaxaca; Guayas, Ecuador; Galapagos Arch.

Geppella decussata Dawson

Dawson, 1959
Isla San Francisco, Gulf of Calif.

Codium amplivesiculatum Setchell & Gardner

Dawson, 1954, 1959
Isla Pond; Puerto Escondido, Gulf of Calif.

Codium anastomosans Setchell & Gardner

Dawson, 1954 (Note: probably equal to *C. simulans*)
Isla Ángel de la Guarda to Isla Tiburón, Gulf of Calif.

Codium cervicorne Setchell & Gardner

Taylor, 1945
Galapagos Arch.

Codium cuneatum Setchell & Gardner

Dawson, 1954; Dawson, Neushul, Wildman, 1960, 1960*a*
San Pedro, Calif., to southern Baja Calif; Gulf of Calif.

Codium decorticatum (Woodward) Howe

Dawson, 1954
Isla Clarión, Revillagigedo Arch.

Codium dichotomum (Hudson) S. F. Gray

Taylor, 1945; Dawson, 1954
Isla Guadalupe; Isla Cedros to Isla Magdalena, Baja Calif.; Mazatlán, Sinaloa; Galapagos Arch.

Codium fernandezianum Setchell

Taylor, 1945; Dawson, 1954
Bahía Santa María, Baja Calif.; Guayas, Ecuador

Codium foveolatum Howe, prox.

Taylor, 1945
Galapagos Arch.

Codium fragile (Suringar) Hariot

Scagel, 1957; Dawson, 1954, 1959*c*
Sitka, Alaska, to Bahía Asunción, Baja Calif.

Codium geppii O. C. Schmidt, complex

Dawson, 1959*b*
Clipperton I.

Codium hubbsii Dawson

Dawson, 1954; Dawson, Neushul, Wildman, 1960
Santa Catalina I., Calif., to Bahía Asunción, Baja Calif.; Isla Guadalupe, Baja Calif.

Codium isabelae Taylor

Dawson, 1954
Isla Clarión, Revillagigedo Arch.; La Paz, Baja Calif.

Codium johnstonei Silva

Dawson, 1954
Santa Cruz I., Calif. to Islas Coronados, Baja Calif.

Codium longiramosum Setchell & Gardner

Dawson, 1954
Isla Pond, Gulf of Calif.; Isla Clarión, Revillagigedo Arch.; Bahía Petatlán, Guerrero

Codium macdougalii Dawson

Dawson, 1954
Puerto Libertad, Sonora

Codium magnum Dawson

Dawson, 1954
Bahía San Quintín, Baja Calif.

Codium palmeri Dawson

Dawson, 1954
Isla Guadalupe, Baja Calif.

Codium santamariae Taylor

Taylor, 1945
Galapagos Arch,; Guayas, Ecuador

Codium setchellii Gardner

Dawson, 1954; Scagel, 1957; Dawson, 1957, 1959*c*; Dawson, Neushul, Wildman, 1960, 1960*a*
Sitka, Alaska, to Punta Abreojos, Baja Calif.; Rocas Alijos

Codium simulans Setchell & Gardner

Dawson, 1954, 1959
Ensenada ?; Isla Guadalupe ?; Punta Santa Rosalía, Baja Calif.; Gulf of Calif.; Isla Clarión, Revillagigedo Arch.

Codium ritteri Setchell & Gardner

Scagel, 1957
Kodiak I., Alaska, to Vancouver I., British Columbia

Halimeda discoidea Decaisne

Dawson, 1954, 1957*b*, 1959
Isla Magdalena, Baja Calif.; Isla Ángel de la Guarda, Gulf of Calif., to Golfo Dulce, Costa Rica

Halimeda opuntia (Linnaeus) Lamouroux

Dawson, 1954
Isla Guadalupe, Baja Calif.; Isla Clarión, Revillagigedo Arch.

Halimeda tuna (Solander) Lamouroux

Dawson, 1954
Isla Clarión, Revillagigedo Arch.

ORDER **DASYCLADALES**

FAM. DASYCLADACEAE

Acetabularia moebii Solms-Laubach

Dawson, 1960*a*
Revillagigedo Arch.; Bahía Carrizal, Colima

Neomeris annulata Dickie

Dawson, 1959
Isla Partida, southern Gulf of Calif.

Neomeris vanbosseae Howe

Dawson, 1954
Isla Socorro, Revillagigedo Arch.

PHYLUM **CHRYSOPHYCOPHYTA**

ORDER **VAUCHERIALES**

FAM. PHYLLOSIPHONACEAE

Ostreobium quekettii Bornet & Flahault

Scagel, 1957
Puget Sound, Wash.

Ostreobium reineckei Bornet

Dawson, 1954
Isla Guadalupe, Baja Calif.; Isla Clarión, Revillagigedo Arch.

FAM. VAUCHERIACEAE

Vaucheria litoria Bang & C. Agardh

Scagel, 1957
Northern Wash.

Vaucheria longicaulis Hoppaugh

Hoppaugh, 1930; Taylor, 1952
Elkhorn Slough, Monterey Co., Calif.

Vaucheria thuretii Woronin

Doty, 1947
Charleston, Oreg.

PHYLUM **PHAEOPHYCOPHYTA**

ORDER **ECTOCARPALES**

FAM. ECTOCARPACEAE

Pylaiella gardneri Collins

Smith, 1944
San Francisco to Carmel, Calif.

Pylaiella littoralis (Linnaeus) Kjellman

Scagel, 1957
Bering Sea to San Pedro, Calif.

Pylaiella tenella Setchell & Gardner

Scagel, 1957
Neah Bay, Wash.; Monterey, Calif.

Pylaiella unilateralis Setchell & Gardner

Setchell & Gardner, 1925; Doty, 1947
Coos Bay, Oreg.

Pylaiella washingtoniensis Jao

Scagel, 1957
Northern Wash.

(Note: Hamel (1939) and others treat some species of *Ectocarpus* under the separate genera *Giffordia* and *Feldmannia*)

Ectocarpus acuminatus Saunders

Smith, 1944
Pacific Grove to San Pedro, Calif.

Ectocarpus acutus Setchell & Gardner var. *acutus*

Scagel, 1957
Puget Sound to Carmel, Calif.

Ectocarpus acutus var. *haplogloiae* Doty

Doty, 1947; Scagel, 1957
Neah Bay, Wash.; Oreg.; Moss Beach, Calif.

Ectocarpus affinis Setchell & Gardner

Setchell & Gardner, 1925
Sitka, Alaska

Ectocarpus breviarticulatus J. Agardh

Dawson, 1954, 1954*c*
Isla Guadalupe, Baja Calif.; Isla San Benedicto, Revillagigedo Arch.; San Agustín, Oaxaca

Ectocarpus bryantii Setchell & Gardner

Dawson, 1954
La Paz, Gulf of Calif.

Ectocarpus chantransioides Setchell & Gardner

Setchell & Gardner, 1925; Hollenberg, 1948
Santa Monica; Corona del Mar, Calif.

Ectocarpus chitonicola Saunders

Smith, 1944
Monterey Peninsula, Calif.

Ectocarpus commensalis Setchell & Gardner

Smith, 1944; Dawson, 1954
Monterey Peninsula, Calif.; Campo Malarrimo, Bahía Vizcaino, Baja Calif.

Ectocarpus confervoides (Roth) LeJolis f. *confervoides*

Coe, 1932; Scagel, 1957
Yakutat Bay, Alaska, to La Jolla, Calif.

Ectocarpus confervoides f. *parvus* (Saunders) Setchell & Gardner

Setchell & Gardner, 1925
San Francisco to San Diego, Calif.

Ectocarpus confervoides f. *typicus* Kuckuck

Setchell & Gardner, 1925; Doty, 1947
Juneau, Alaska, to San Francisco, Calif.

Ectocarpus corticulatus Saunders

Scagel, 1957
Popof I., Alaska, to San Pedro, Calif.

Ectocarpus cylindricus Saunders f. *cylindricus*

Coe, 1932; Hollenberg, 1948; Scagel, 1957
Northern Wash. to La Jolla, Calif.

Ectocarpus cylindricus f. *codiophilus* Setchell & Gardner

Smith, 1944; Dawson, 1945*b*, 1960*a*
Monterey Peninsula; La Jolla, Calif.; Punta Thurloe, Baja Calif.

Ectocarpus dimorphus Silva

Dawson, 1954 (as *E. variabilis*); Silva, 1957; Scagel, 1957
Hope I., British Columbia, to Bahía Asunción, Baja Calif.; Gulf of Calif.

Ectocarpus duchassaignianus Grunow

Dawson, 1954
Isla Guadalupe, Baja Calif.; Isla María Magdalena, Nayarit; Isla Socorro, Revillagigedo Arch.

Ectocarpus ellipticus Saunders

Smith, 1944
Monterey Peninsula, Calif.

Ectocarpus ensenadanus Gardner

Dawson, 1954
Ensenada, Baja Calif.

Ectocarpus eramosus Setchell & Gardner

Setchell & Gardner, 1925
Tomales Bay, Calif.

Ectocarpus flagelliferus Setchell & Gardner

Setchell & Gardner, 1925
Sitka, Alaska

Ectocarpus flocculiformis Setchell & Gardner

Setchell & Gardner, 1925; Dawson, 1954
La Jolla, Calif.; Isla Cedros; Campo Malarrimo, Baja Calif.

Ectocarpus fructuosus Setchell & Gardner

Setchell & Gardner, 1925
Moss Beach, Calif.

Ectocarpus globifer Kützing

Setchell & Gardner, 1925
San Pedro to La Jolla, Calif.

Ectocarpus gonodioides Setchell & Gardner

Smith, 1944; Dawson, 1954
Carmel, Calif.; Isla Smith, Gulf of Calif.

Ectocarpus granulosoides Setchell & Gardner var. *granulosoides*

Smith, 1944; Dawson, 1945*b*
Monterey to La Jolla, Calif.

Ectocarpus granulosoides var. *pygmaeus* Setchell & Gardner

Dawson, 1954
Isla San Martín, Baja Calif.

Ectocarpus granulosus (J. E. Smith) C. Agardh
Coe, 1932; Dawson, 1954; Scagel, 1957; Dawson, 1959*c*, 1960*a*
Southern British Columbia to Punta Thurloe, Baja Calif.

Ectocarpus hancockii Dawson
Dawson, 1954
Isla Turner, Gulf of Calif.

Ectocarpus hemisphericus Saunders f. *hemisphericus*
Setchell & Gardner, 1925
San Pedro to San Diego, Calif.

Ectocarpus hemisphericus f. *minor* Saunders
Setchell & Gardner, 1925; Dawson, 1945*b*
Southern Calif.

Ectocarpus indicus Sonder
Dawson, 1959*b*
Clipperton I.

Ectocarpus irregularis Kützing
Dawson, 1954*c*, 1959*b*
Isla San Benedicto, Revillagigedo Arch.; Clipperton I.?

Ectocarpus isopodicola Dawson
Dawson, 1946
Newport Bay, Calif.

Ectocarpus luteolus Sauvageau
Setchell & Gardner, 1925
San Francisco, Calif.

Ectocarpus mesogloiae Setchell & Gardner
Smith, 1944
Carmel, Calif.

Ectocarpus mitchellae Harvey
Setchell & Gardner, 1925; Dawson, 1954, 1959, 1959*c*
Southern Calif. to San Jose del Cabo, Baja Calif.; Punta Peñasco, Sonora; southern Gulf of Calif. ?

Ectocarpus mucronatus Saunders
Scagel, 1957; Dawson, 1954, 1959*c*
Vancouver I., British Columbia, to San Pedro, Calif.; Punta Peñasco, Sonora

Ectocarpus oviger Harvey
Scagel, 1957
Southern British Columbia to Carmel, Calif.

Ectocarpus saundersii Setchell & Gardner
Smith, 1944
Monterey Peninsula, Calif.

Ectocarpus parksii Setchell & Gardner
Setchell & Gardner, 1925
San Francisco Bay, Calif.

Ectocarpus pygmaeus Areschoug
Dawson, 1954 (as *E. confervoides* f. *pygmaeus*); Scagel, 1957
Shumagin I., Alaska, to Carmel, Calif.; Punta Descanso, Baja Calif.

Ectocarpus siliculosus (Dillwyn) Lyngbye f. *siliculosus*
Setchell & Gardner, 1925; Sanborn & Doty, 1946; Doty, 1947
Coos Bay, Oreg., to San Francisco Bay, Calif.

Ectocarpus siliculosis f. *subulatus* (Kützing) Setchell & Gardner
Setchell & Gardner, 1925
San Francisco Bay, Calif.

Ectocarpus simulans Setchell & Gardner
Smith, 1944
Monterey, Calif.

Ectocarpus socialis Setchell & Gardner
Setchell & Gardner, 1925; Dawson, 1945*b*
Southern Calif.

Ectocarpus sonorensis Dawson
Dawson, 1954
Guaymas, Gulf of Calif.

Ectocarpus taoniae Setchell & Gardner
Setchell & Gardner, 1925
San Pedro, Calif.

Ectocarpus terminalis Kützing
Scagel, 1957
Unalaska, Alaska, to Laguna Beach, Calif.

Ectocarpus tomentosus (Hudson) Lyngbye
Scagel, 1957; Taylor, 1945
Kodiak I., Alaska, to Laguna Beach, Calif.; Galapagos Arch.

Zosterocarpus abyssicolus Taylor
Taylor, 1945
Galapagos Arch.

Streblonema aecidioides f. *pacificum* Setchell & Gardner
Scagel, 1957
Southern British Columbia to northern Wash.

Streblonema anomalus Setchell & Gardner
Smith, 1944
Monterey; San Pedro, Calif.

Streblonema codicola Setchell & Gardner
Dawson, 1954
Isla Guadalupe, Baja Calif.

Streblonema corymbiferum Setchell & Gardner
Smith, 1944
Monterey; San Pedro, Calif.

Streblonema desmarestiae Gardner
Gardner, 1940; Scagel, 1957
San Juan I., Wash.

Streblonema evagatum Setchell & Gardner
Smith, 1944
Monterey, Calif.

Streblonema investiens (Collins) Setchell & Gardner
Setchell & Gardner, 1925; Dawson, 1945*b*
San Pedro to La Jolla, Calif.

Streblonema irregulare Saunders
Setchell & Gardner, 1925
Sitka, Alaska

Streblonema johnstonae Setchell & Gardner
Setchell & Gardner, 1925
San Pedro, Calif.

Streblonema minutissimum Saunders
Setchell & Gardner, 1925
Sitka, Alaska

Streblonema myrionematoides Setchell & Gardner
Setchell & Gardner, 1925
Moss Beach, Calif.

Streblonema pacificum Saunders
Setchell & Gardner, 1925
Yakutat Bay, Alaska, to San Francisco Bay, Calif.

Streblonema penetrale Setchell & Gardner
Smith, 1944
Pacific Grove, Calif.

Streblonema porphyrae Setchell & Gardner
Smith, 1944
Monterey Peninsula, Calif.

Streblonema rugosum Setchell & Gardner
Scagel, 1957
Northern Wash.

Streblonema scabiosum Setchell & Gardner
Setchell & Gardner, 1925
San Francisco, Calif.

Streblonema transfixum Setchell & Gardner
Setchell & Gardner, 1925
San Pedro, Calif.

Streblonema vorax Setchell & Gardner
Setchell & Gardner, 1925
Sitka, Alaska

FAM. RALFSIACEAE

Ralfsia californica Setchell & Gardner
Dawson, 1954
Central Calif.; Isla Tiburón to Isla Espíritu Santo, Gulf of Calif.; Bahía Tenacatita, Jalisco

Ralfsia clavata (Carmichael) Crouan
Setchell & Gardner, 1925
Unalaska Bay, Alaska

Ralfsia fungiformis (Gunnerus) Setchell & Gardner
Scagel, 1957
Bering Sea to Coos Bay, Oreg.

Ralfsia hancockii Dawson

Dawson, 1954, 1954*c*
San Jose del Cabo, Baja Calif.; Isla San Benedicto, Revillagigedo Arch.

Ralfsia hesperia Setchell & Gardner

Smith, 1944
Carmel; Corona del Mar, Calif.

Ralfsia occidentalis Hollenberg

Dawson, 1954
Isla Socorro, Revillagigedo Arch.

Ralfsia pacifica Hollenberg, in Dawson

Dawson, 1954; Scagel, 1957
Unalaska, Alaska, to Baja Calif.; northern Gulf of Calif.

Ralfsia pangoensis var. *galapagensis* Setchell & Gardner

Setchell & Gardner, 1937
Galapagos Arch.

Hapterophycus canaliculatus Setchell & Gardner

Dawson, 1954, 1959*c*
Redondo, Calif., to Islas San Benito, Baja Calif.

Lithoderma fatiscens Areschoug

Setchell & Gardner, 1925
Bering Sea; Unalaska, Alaska

Hapalospongidion gelatinosum Saunders

Smith, 1944; Dawson, 1954
Carmel, Calif., to Punta Banda, Baja Calif.; Bahía Petatlán, Guerrero

ORDER SPHACELARIALES

FAM. SPHACELARIACEAE

Sphacelaria brevicorne Setchell & Gardner

Dawson, 1954
Vicinity of La Paz, Gulf of Calif.

Sphacelaria californica Sauvageau

Setchell & Gardner, 1925
San Pedro to San Diego, Calif.

Sphacelaria didichotoma Saunders

Smith, 1944
Monterey to southern Calif.

Sphacelaria furcigera Kützing

Dawson, 1954, 1957*b*, 1959, 1959*b*
La Jolla, Calif., to Isla Magdalena, Baja Calif.; Gulf of Calif.; Golfo de Nicoya, Costa Rica; Clipperton I.; Galapagos Arch.

Sphacelaria hancockii Dawson

Dawson, 1954, 1959
Bahía Viscaino, Baja Calif.; Gulf of Calif.

Sphacelaria masonii Setchell & Gardner

Dawson, 1954
Isla Clarión, Revillagigedo Arch.

Sphacelaria novae-hollandiae Sonder

Dawson, 1954, 1957*b*
Isla Guadalupe, Baja Calif.; Golfo Dulce, Costa Rica

Sphacelaria racemosa Greville

Scagel, 1957
Bering Sea to Oreg.

Sphacelaria subfusca Setchell & Gardner

Scagel, 1957
Sitka, Alaska, to Redondo, Calif.

Sphacelaria tribuloides Meneghini

Dawson, 1959
Isla San Diego, Gulf of Calif.

ORDER CUTLERIALES

FAM. CUTLERIACEAE

Cutleria hancockii Dawson

Dawson, 1954
Northern Gulf of Calif.

ORDER TILOPTERIDALES

FAM. TILOPTERIDACEAE

Masonophycus paradoxa Setchell & Gardner

Dawson, 1954
Isla Clarión, Revillagigedo Arch.

ORDER DICTYOTALES

FAM. DICTYOTACEAE

Pachydictyon coriaceum (Holmes) Okamura

Dawson, 1954, 1959, 1959*c*; Dawson, Neushul, Wildman, 1960

Coos Bay, Oreg., to Punta Entrada, Isla Magdalena, Baja Calif.; northern Gulf of Calif. south to Isla Ildefonso

Dictyota binghamiae J. Agardh

Dawson, 1954; Dawson, Neushul, Wildman, 1960, 1960*a*

Coos Bay, Oreg., to central Baja Calif.

Dictyota concrescens Taylor

Dawson, 1954

Cabo San Lazaro, Isla Magdalena, Baja Calif.

Dictyota crenulata J. Agardh

Dawson, 1954, 1954*c*, 1959

Isla San Benedicto, Revillagigedo Arch.; Isla San Diego, Gulf of Calif., to Puerto Culebra, Costa Rica

Dictyota dichotoma (Hudson) Lamouroux

Dawson, 1954, 1957, 1959

Gulf of Calif.; tropical Pacific Mexico and Central America ?; Galapagos Arch.

Dictyota divaricata Lamouroux

Dawson, 1954, 1957, 1957*b*, 1959

Isla Guadalupe, Baja Calif.; Revillagigedo Arch.; La Paz, Gulf of Calif., to Isla La Plata, Ecuador

Dictyota flabellata (Collins) Setchell & Gardner

Smith, 1944; Taylor, 1945; Doty, 1947; Dawson, 1954, 1959, 1959*c*; Dawson, Neushul & Wildman, 1960

Southern Calif. to Punta Santa Rosalía, Baja Calif.; northern Gulf of Calif. south to Isla Tortuga

Dictyota friabilis Setchell

Dawson, 1957*b*; Dawson, Neushul & Wildman, 1960*a*

Islas San Benito, Baja Calif.; Golfo de Nicoya, Costa Rica ?

Dictyota major Taylor

Taylor, 1945

Galapagos Arch.

Dictyota masonii Setchell & Gardner

Dawson, 1954, 1960*a*

Isla Margarita, Baja Calif. ?; Isla Clarión, Revillagigedo Arch., Isla del Caño, Costa Rica ?

Dilophus okamurai Dawson

Dawson, 1954

Vicinity of San Lucas, Baja Calif.

Dilophus pinnatus Dawson

Dawson, 1954

Miramar, Nayarit

Dictyopteris cokeri (Howe) Taylor

Taylor, 1945

Galapagos Arch.

Dictyopteris delicatula Lamouroux

Dawson, 1954

Revillagigedo Arch.; Clipperton I.

Dictyopteris diaphana Taylor

Taylor, 1945

Galapagos Arch.

Dictyopteris johnstonei Gardner

Silva, 1957 (indicating probable identity with *D. zonarioides*)

Santa Cruz I., Calif., to Islas San Benitos, Baja Calif.

Dictyopteris membranacea (Stackhouse) Batters

Dawson, 1954

Isla Guadalupe; Scammons Lagoon, Baja Calif.

Dictyopteris repens (Okamura) Børgesen

Dawson, 1957, 1957*b*, 1959, 1959*b*

Isla Carmén, Gulf of Calif.; Golfo de Nicoya, Costa Rica; Clipperton I.

Dictyopteris zonarioides Farlow

Dawson, 1954, 1959, 1959*c*; Dawson, Neushul & Wildman, 1960

Southern Calif. to San Jose del Cabo, Baja Calif.; northern Gulf of Calif. south to Isla Ildefonso

Taonia lennebackerae Farlow

Dawson, 1954, 1959*c*; Dawson, Neushul, Wildman, 1960, 1960*a*
Lechuza Point, Calif., to Bahía Asunción, Baja Calif.

Syringoderma abyssicola (Setchell & Gardner) Levring

Scagel, 1957
Northern Wash.

Spatoglossum ecuadoreanum Taylor

Taylor, 1945
Galapagos Arch.

Spatoglossum howellii Setchell & Gardner

Dawson, 1954; Dawson, Neushul, Wildman, 1960*a*
Central Baja Calif.; Galapagos Arch.

Spatoglossum lanceolatum Dawson

Dawson, 1954
Ensenada de San Francisco, Sonora

Spatoglossum sp. aff. *S. schroederi* (Mertens) J. Agardh

Dawson, 1959
Isla San Pedro Nolasco, Gulf of Calif.

Spatoglossum schmittii Taylor

Taylor, 1945
Galapagos Arch.

Spatoglossum subflabellatum Dawson

Dawson, 1954
Ensenada de San Francisco, Sonora

Glossophora galapagensis Taylor

Taylor, 1945
Galapagos Arch.

Zonaria lobata C. Agardh

Taylor, 1945
Galapagos Arch.

Zonaria farlowii Setchell & Gardner

Dawson, 1954, 1959*c*; Dawson, Neushul, Wildman, 1960
Santa Barbara Co., Calif., to Isla Magdalena, Baja Calif.

Pocockiella variegata (Lamouroux) Papenfuss

Taylor, 1945; Dawson, 1954, 1954*c*, 1957, 1957*b*, 1959, 1959*b*
Rocas Alijos, Baja Calif.; Revillagigedo Arch.; southern Gulf of Calif.; Costa Rica; Guayas, Ecuador; Galapagos, Arch.; Clipperton I.

Padina caulescens Thivy

Dawson, 1954, 1957*b*, 1959
Isla Monserrate, Gulf of Calif.; Isla María Magdalena, Nayarit; Golfo de Nicoya, Costa Rica

Padina concrescens Thivy

Taylor, 1945
Galapagos Arch.

Padina crispata Thivy

Dawson, 1954, 1957*b*, 1959
Southern Gulf of Calif. to Bahía Honda, Panamá

Padina durvillaei Bory

Taylor, 1945; Dawson, 1954, 1957, 1957*b*, 1959; Dawson, Neushul, Wildman, 1960
Punta María, Baja Calif., to Guayas, Ecuador; Galapagos Arch.

Padina mexicana Dawson

Dawson, 1954, 1959
Isla Turner to La Paz, Gulf of Calif.

Padina tetrastromatica Hauck

Dawson, 1954
Isla María Madre, Nayarit ?

ORDER CHORDARIALES

FAM. MYRIONEMATACEAE

Myrionema attenuatum Setchell & Gardner

Smith, 1944
Monterey Peninsula, Calif.

Myrionema balticum f. *californicum* Setchell & Gardner

Smith, 1944
Monterey Peninsula, Calif.

Myrionema balticum f. *pedicellatum* Setchell & Gardner

Setchell & Gardner, 1925
Point Carmel, Calif.

Myrionema compsonematoides Setchell & Gardner

Scagel, 1957
Friday Harbor, Wash.

Myrionema corunnae f. *angulatum* Setchell & Gardner

Setchell & Gardner, 1925
San Francisco, Calif.

Myrionema corunnae f. *sterile* Setchell & Gardner

Smith, 1944
Carmel, Calif.

Myrionema corunnae f. *uniforme* Setchell & Gardner

Setchell & Gardner, 1925
San Mateo Co., Calif.

Myrionema foecundum f. *ramulosum* Setchell & Gardner

Scagel, 1957
Friday Harbor, Wash.

Myrionema foecundum f. *simplicissimum* Setchell & Gardner

Scagel, 1957
Kodiak I., Alaska, to central Calif.

Myrionema foecundum f. *subulatum* Setchell & Gardner

Setchell & Gardner, 1925
San Francisco, Calif.

Myrionema globosum f. *affine* Setchell & Gardner

Scagel, 1957
Sitka, Alaska, to Point Carmel, Calif.

Myrionema minutissimum Setchell & Gardner

Setchell & Gardner, 1925
San Francisco, Calif.

Myrionema obscurum Setchell & Gardner

Setchell & Gardner, 1925
Moss Beach, Calif.

Myrionema phyllophyllum Setchell & Gardner

Setchell & Gardner, 1925
Sitka, Alaska

Myrionema primarium Setchell & Gardner

Scagel, 1957
Alaska to Carmel, Calif.

Myrionema setiferum Setchell & Gardner

Setchell & Gardner, 1925
Sitka, Alaska

Myrionema strangulans Greville

Scagel, 1957
Sitka, Alaska, to Carmel, Calif.

Compsonema coniferum Setchell & Gardner

Smith, 1944
Monterey Peninsula, Calif.

Compsonema dubium Setchell & Gardner

Smith, 1944
Monterey Peninsula, Calif.

Compsonema fasciculatum Setchell & Gardner

Smith, 1944
Pacific Grove, Calif.

Compsonema fructuosum Setchell & Gardner

Setchell & Gardner, 1925
Tomales Bay, Calif.

Compsonema immixtum Setchell & Gardner

Dawson, 1954
Isla Partida, Gulf of Calif.

Compsonema intricatum Setchell & Gardner

Smith, 1944
Carmel, Calif.

Compsonema myrionematoides Setchell & Gardner

Smith, 1944
Pacific Grove, Calif.

Compsonema nummuloides Setchell & Gardner
Setchell & Gardner, 1925
Moss Beach, Calif.

Compsonema pusillum Setchell & Gardner
Smith, 1944
Carmel, Calif.

Compsonema ramulosum Setchell & Gardner
Smith, 1944
Carmel, Calif.

Compsonema secundum Setchell & Gardner
Smith, 1944
Moclips, Wash., to Carmel, Calif.

Compsonema serpens Setchell & Gardner
Smith, 1944
Monterey Peninsula, Calif.

Compsonema sessile Setchell & Gardner
Scagel, 1957
Neah Bay, Wash.

Compsonema speciosum f. *piliferum* Setchell & Gardner
Setchell & Gardner, 1925
Moclips, Wash.

Compsonema sporangiiferum Setchell & Gardner
Scagel, 1957
Neah Bay, Wash.

Compsonema streblonematoides Setchell & Gardner
Setchell & Gardner, 1925
Tomales Bay, Calif.

Compsonema tenue Setchell & Gardner
Setchell & Gardner, 1925
Sitka, Alaska

Hecatonema clavatum Setchell & Gardner
Setchell & Gardner, 1925
Tomales Bay, Calif.

Hecatonema lawsonii Setchell & Gardner
Setchell & Gardner, 1925
Uyak Bay, Alaska

Hecatonema variabile Setchell & Gardner
Smith, 1944
Monterey Peninsula, Calif.

FAM. ELACHISTACEAE

Halothrix lumbricalis (Kützing) Reinke
Dawson, 1954
Isla Guadalupe, Baja Calif.

Elachistea fucicola (Velley) Areschoug
Scagel, 1957
Sitka, Alaska, to Coos Bay, Oreg.

Elachistea lubrica Ruprecht
Setchell & Gardner, 1925
Prince William Sound to Wrangell, Alaska

Gonodia johnstonii Setchell & Gardner
Dawson, 1954
Isla San Marcos, Gulf of Calif.

Gonodia marchantae Setchell & Gardner
Dawson, 1954
La Paz, Gulf of Calif.

FAM. CORYNOPHLOEACEAE

Petrospongium rugosum (Okamura) Setchell & Gardner
Smith, 1944; Dawson, 1954, 1959*c*
San Mateo Co., Calif., to Bahía Asunción, Baja Calif.

Leathesia difformis (Linnaeus) Areschoug
Coe, 1932; Dawson, 1954; Scagel, 1957; Dawson, 1959*c*
Bering Sea to Bahía Asunción, Baja Calif.

Leathesia nana Setchell & Gardner
Smith, 1944; Doty, 1947; Dawson, 1958, 1959*c*
Oreg.; Monterey Peninsula; Carpinteria, Calif.

FAM. CHORDARIACEAE

Eudesme virescens (Carmichael) J. Agardh
Scagel, 1957
Shumagin I. to Sitka, Alaska; La Jolla, Calif.

Haplogloia andersonii (Farlow) Levring
Scagel, 1957; Dawson, 1954
Sitka, Alaska, to Cabo Colnett, Baja Calif.

Haplogloia kuckuckii Kylin
Scagel, 1957
Sitka, Alaska, to Friday Harbor, Wash.

Chordaria dissessa Setchell & Gardner
Scagel, 1957
Northern Wash.

Chordaria flagelliformis (Müller) C. Agardh
Setchell & Gardner, 1925
Bering Sea to Sitka, Alaska

Chordaria gracilis Setchell & Gardner
Setchell & Gardner, 1925
Unalaska, Alaska

Saundersella simplex (Saunders) Kylin
Scagel, 1957
Cook Inlet, Alaska, to southern British Columbia

Heterochordaria abietina (Ruprecht) Setchell & Gardner
Okamura, 1933; Scagel, 1957
Bering Sea to Point Conception, Calif.

FAM. SPERMATOCHNACEAE

Nemacystus brandegeei (Setchell & Gardner) Kylin
Dawson, 1954, 1959
Scammon Lagoon, Baja Calif.; Gulf of Calif.

ORDER SPOROCHNALES

FAM. SPOROCHNACEAE

Carpomitra costata (Stackhouse) Batters
Dawson, Neushul, Wildman, 1960*a*
Vancouver I., British Columbia; Bahía Viscaino, Baja Calif.

Carpomitra luxurians Taylor
Taylor, 1945
Galapagos Arch.

Sporochnus bolleanus Montagne
Taylor, 1945; Dawson, Neushul, Wildman, 1960*a*
Isla Guadalupe; central Baja Calif.; Galapagos Arch.

Sporochnus pedunculatus (Hudson) C. Agardh
Dawson, 1954; Dawson, Neushul, Wildman, 1960*a*
Isla Guadalupe; Scammon Lagoon, Baja Calif.

Sporochnus rostratus Taylor
Taylor, 1945
Galapagos Arch.

ORDER DESMARESTIALES

FAM. DESMARESTIACEAE

Desmarestia farcta Setchell & Gardner
Scagel, 1957
Northern Wash.

Desmarestia filamentosa Dawson
Dawson, 1954
Isla Ángel de la Guarda, Gulf of Calif.

Desmarestia foliacea Pease
Scagel, 1957
Northern Wash.

Desmarestia herbacea (Turner) Lamouroux
Scagel, 1957; Dawson, 1959*c*; Dawson, Neushul, Wildman, 1960
Kodiak Is., Alaska, to Isla Cedros, Baja Calif.

Desmarestia intermedia Postels & Ruprecht
Scagel, 1957
Bering Sea to Oreg.

Desmarestia jordanii Gardner
Gardner, 1940
Ventura, Calif.

Desmarestia latifrons (Ruprecht) Kützing
Doty, 1947
Coos Bay, Oreg., to Point Sur, Calif.

Desmarestia latissima Setchell & Gardner
Scagel, 1957
Northern Wash.

Desmarestia ligulata (Lightfoot) Lamouroux

Scagel, 1957
Southern British Columbia to northern Wash.

Desmarestia linearis Gardner, in Smith

Smith, 1944
Monterey Peninsula, Calif.

Desmarestia media (C. Agardh) Greville var. *media*

Setchell & Gardner, 1925; Okamura, 1933
Atka I., to Unalaska, Alaska

Desmarestia media var. *tenuis* Setchell & Gardner

Scagel, 1957
Juneau, Alaska, to Puget Sound, Wash.

Desmarestia mexicana Dawson

Dawson, 1954
Isla Ángel de la Guarda, Gulf of Calif.

Desmarestia munda Setchell & Gardner

Scagel, 1957; Dawson, Neushul, Wildman, 1960
Northern British Columbia to Punta Pequeña, Baja Calif.; Galapagos Arch.

Desmarestia pacifica Setchell & Gardner

Dawson, 1954
Santa Catalina I., Calif.; Isla Guadalupe, Baja Calif. ?

Desmarestia tabacoides Okamura

Dawson, 1950*a*; Dawson, Neushul, Wildman, 1960
Santa Cruz I. to La Jolla, Calif.

Desmarestia tropica Taylor

Taylor, 1945
Galapagos Arch.

Desmarestia viridis (Müller) Lamouroux

Scagel, 1957
Alaska to Carmel, Calif.

ORDER DICTYOSIPHONALES

FAM. STRIARIACEAE

Stictyosiphon tortilis (Ruprecht) Reinke

Scagel, 1957
Port Clarence, Alaska; Monterey Peninsula, Calif.

FAM. PUNCTARIACEAE

Punctaria chartacea Setchell & Gardner

Setchell & Gardner, 1925
Sitka, Alaska

Punctaria expansa Setchell & Gardner

Scagel, 1957
Southern British Columbia to northern Wash.

Punctaria hesperia Setchell & Gardner

Scagel, 1957
Victoria, British Columbia; Monterey; San Pedro, Calif.

Punctaria latifolia Greville

Setchell & Gardner, 1925
Metlacatla; Baranoff I., Alaska

Punctaria lobata (Saunders) Setchell & Gardner

Setchell & Gardner, 1925
Prince William Sound to Sitka, Alaska

Punctaria occidentalis Setchell & Gardner

Smith, 1944
Monterey, Calif.

Punctaria orbiculata Jao

Scagel, 1957
San Juan I., Wash.

Punctaria plantaginea Greville

Saunders, 1901; Setchell & Gardner, 1925
Yakutat Bay, Alaska ?

Halorhipis winstonii (Anderson) Saunders

Smith, 1944
Monterey Peninsula, Calif.

Soranthera ulvoidea Postels & Ruprecht f. *ulvoidea*

Scagel, 1957; Dawson, 1958, 1959*c*
Bering Sea to Government Point, Calif.

Soranthera ulvoidea f. *diffórmis* Setchell & Gardner

Scagel, 1957
Bering Sea to Cape Flattery, Wash.

Myelophycus intestinale Saunders

Okamura, 1933; Scagel, 1957
Atka I., Alaska, to Puget Sound, Wash.

Ishige foliaceae Okamura

Dawson, 1954; Setchell & Gardner, 1924 (as *Polyopes sinicola*)
Northern Gulf of Calif.

Phaeostrophion australe Dawson

Dawson, 1958, 1959*c*
Government Point, Calif.

Phaeostrophion irregulare Setchell & Gardner

Setchell & Gardner, 1925; Doty, 1947
Coos Bay, Oreg.; Bolinas, Calif.

FAM. SCYTOSIPHONACEAE

Scytosiphon attenuatus (Foslie) Doty

Doty, 1947
Coos Bay, Oreg. to central Calif.

Scytosiphon bullosus Saunders

Dawson, 1954; Scagel, 1957
Cook Inlet, Alaska, to central Calif.; central Baja Calif.; Gulf of Calif.; Galapagos Arch.

Scytosiphon complanatus (Rosenvinge) Doty

Doty, 1947
Cape Arago, Oreg., to Carmel, Calif.

Scytosiphon lomentaria (Lyngbye) J. Agardh f. *lomentaria*

Coe, 1932; Dawson, 1954; Scagel, 1957; Dawson, 1959*c*
Bering Sea to Islas San Benito, Baja Calif.

Scytosiphon lomentaria f. *cylindricus* subf. *maculatus* Setchell & Gardner

Setchell & Gardner, 1925
San Francisco, Calif.

Scytosiphon complanatus (Rosenvinge) Doty

Doty, 1947
Cape Arago, Oreg., to Carmel, Calif.

Petalonia debilis (C. Agardh) Derbès & Solier f. *debilis*

Coe, 1932 (as *Ilea fascia*); Dawson, 1954 (as *Ilea fascia*); Scagel, 1957; Dawson, 1960*a*; (see also Setchell & Gardner, 1925 for *Ilea fascia* f. *caespitosa* and *Ilea fascia* f. *zosterifolia*)
Unalaska, Alaska, to Isla Magdalena, Baja Calif.

Endarachne binghamiae J. Agardh

Dawson, 1954, 1959*c*
Southern Calif. to Bahía Asunción, Baja Calif.

Colpomenia mollis Taylor

Taylor, 1945
Isla Gorgona, Colombia

Colpomenia ramosa Taylor

Dawson, 1954
Isla Cedros, Baja Calif., to Puerto Parker, Costa Rica

Colpomenia sinuosa (Roth) Derbès & Solier f. *sinuosa*

Taylor, 1945; Coe, 1932; Dawson, 1954, 1957, 1959, 1959*c*; Scagel, 1957; Dawson, Neushul, Wildman, 1960
Yakutat Bay, Alaska, to Puerto Parker, Costa Rica; Clipperton I.; Galapagos Arch.

Colpomenia sinuosa f. *expansa* Saunders

Setchell & Gardner, 1925
Avalon, Santa Catalina I., Calif.

Colpomenia sinuosa f. *tuberculata* (Saunders) Setchell & Gardner

Dawson, 1954; Scagel, 1957; Dawson, 1959
Unalaska, Alaska, to southern Baja Calif.; Gulf of Calif.

Hydroclathrus clathratus (Bory) Howe

Coe, 1932; Dawson, 1954; Taylor, 1945; Dawson, 1959
La Jolla, Calif. to Scammon Lagoon, Baja Calif.; southern Gulf of Calif.; Guayas, Ecuador

Rosenvingea intricata (J. Agardh) Børgesen

Dawson, 1954; Taylor, 1945; Dawson, 1959
Bahía Tepoca, Sonora, to Acapulco, Guerrero; Revillagigedo Arch.; Guayas, Ecuador

Rosenvingea orientalis (J. Agardh) Børgesen

Dawson, 1960*a*
Bahía Potrero Grande, Costa Rica

FAM. CHNOOSPORACEAE

Chnoospora implexa Hering, in J. Agardh

Dawson, 1957, 1957*b*, 1959, 1959*b*
Southern Gulf of Calif.; Golfo de Nicoya, Costa Rica; Clipperton I.

Chnoospora minima (Hering) Papenfuss

Papenfuss, 1956; Dawson, 1954, 1954*c* (both as *C. pacifica*)
La Paz, Gulf of Calif., to San Agustín, Oaxaca; Isla San Benedicto, Revillagigedo Arch.

Chnoospora pannosa J. Agardh

Dawson, 1954
Isla Guadalupe, Baja Calif.

FAM. DICTYOSIPHONACEAE

Coilodesme bulligera Stroemfelt

Okamura, 1933; Scagel, 1957
Aleutian Islands to Coos Bay, Oreg.

Coilodesme californica (Ruprecht) Kjellman

Scagel, 1957; Dawson, Neushul, Wildman, 1960, 1960*a*
Queen Charlotte Str., British Columbia, to central Baja Calif.

Coilodesme corrugata Setchell & Gardner

Setchell & Gardner, 1925
Santa Catalina I., Calif.

Coilodesme cystoseirae (Ruprecht) Setchell & Gardner

Setchell & Gardner, 1925
Kukak Bay; Yakutat Bay, Alaska

Coilodesme polygnampta Setchell & Gardner

Setchell & Gardner, 1925
Amaknak I.; Unalaska, Alaska

Coilodesme rigida Setchell & Gardner

Setchell & Gardner, 1925; Dawson, 1959*c*; Dawson, Neushul, Wildman, 1960, 1960*a*
Redondo, Calif., to Bahía Tortuga, Baja Calif.

Coilodesme sitchensis Setchell & Gardner

Setchell & Gardner, 1925
Sitka, Alaska

Dictyosiphon foeniculaceus (Hudson) Greville

Scagel, 1957
Bering Sea to Puget Sound, Wash.

Dictyosiphon hippuroides (Lyngbye) Kützing

Setchell & Gardner, 1925
Bering Sea to Unalaska, Alaska

Dictyosiphon hispidus Kjellman

Setchell & Gardner, 1925
Orca, Alaska

Dictyosiphon sinicola Gardner

Scagel, 1957
Southern British Columbia to northern Wash.

Dictyosiphon tenuis Setchell & Gardner

Setchell & Gardner, 1925
Golofin Bay, Alaska

ORDER LAMINARIALES

FAM. CHORDACEAE

Chorda filum (Linnaeus) Lamouroux

Scagel, 1957
Bering Sea to Puget Sound, Wash. ?

FAM. LAMINARIACEAE

Laminaria complanata (Setchell & Gardner) Setchell

Scagel, 1957
Friday Harbor, Wash.

Laminaria cordata Dawson

Dawson, 1950*a*
Santa Catalina I., Calif.

Laminaria cuneifolia J. Agardh f. *cuneifolia*

Scagel, 1957
Bering Sea to Oreg.

Laminaria cuneifolia f. *amplissima* Setchell & Gardner

Scagel, 1957
Sitka, Alaska, to Cape Flattery, Wash.

Laminaria cuneifolia f. *angusta* Setchell & Gardner

Scagel, 1957
Southern British Columbia to northern Wash.

Laminaria cuneifolia f. *subsimplex* Setchell & Gardner

Scagel, 1957
Southern British Columbia to northern Wash.

Laminaria dentigera Kjellman

Setchell & Gardner, 1925
Aleutian Islands, Alaska

Laminaria ephemera Setchell

Scagel, 1957
Southern British Columbia to Oreg.; Monterey Peninsula, Calif.

Laminaria farlowii Setchell

Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Santa Cruz, Calif., to Bahía del Rosario, Baja Calif.

Laminaria longipes Bory

Okamura, 1933; Setchell & Gardner, 1925
Aleutian Islands, Alaska

Laminara personata Setchell & Gardner

Setchell & Gardner, 1925
Yakutat Bay to Sitka, Alaska

Laminaria platymeris De la Pylaie

Scagel, 1957
Bering Sea to northern Wash.

Laminaria saccharina (Linnaeus) Lamouroux f. *saccharina*

Scagel, 1957
Alaska to Coos Bay, Oreg.

Laminaria saccharina f. *linearis* J. Agardh

Scagel, 1957
Unga, Alaska, to Puget Sound, Wash.

Laminaria saccharina f. *membranacea* J. Agardh

Scagel, 1957
Alaska to Coos Bay, Oreg.

Laminaria setchellii Silva

Scagel, 1957
Northern British Columbia to southern Calif. Channel Islands

Laminaria sinclairii (Harvey in Hooker f.) Farlow, Anderson & Eaton

Scagel, 1957; Dawson, 1958, 1959*c*
Southern British Columbia to Ventura Co., Calif.

Pleurophycus gardneri Setchell & Saunders

Scagel, 1957
Yakutat Bay, Alaska, to Coos Bay, Oreg.

Cyamathere triplicata (Postels & Ruprecht) J. Agardh

Scagel, 1957
Bering Sea to northern Wash.

Costaria costata (Turner) Saunders

Scagel, 1957
Shumagin I., Alaska, to San Pedro, Calif.

Costaria mertensii J. Agardh

Scagel, 1957
Bering Sea to Monterey, Calif.

Thalassiophyllum clathrus (Gmelin) Postels & Ruprecht

Okamura, 1933; Scagel, 1957
Bering Sea to Straits of Juan de Fuca ?

Agarum cribrosum (Mertens) Bory

Scagel, 1957
Bering Sea to northern Wash.

Agarum fimbriatum Harvey

Scagel, 1957; Dawson, Neushul & Wildman, 1960
Puget Sound, Wash., to southern Calif. Channel Islands

Hedophyllum bongardianum (Postels & Ruprecht) Yendo

Miyabe & Nagai, 1932; Scagel, 1957 (as *Hedophyllum subsessile*)
Bering Sea to Coos Bay, Oreg.

Hedophyllum sessile (C. Agardh) Setchell

Okamura, 1933; Scagel, 1957
Aleutian Islands to Point Sur, Calif.

Arthrothamnus bifidus (Gmelin) J. Agardh

Setchell & Gardner, 1925
Aleutian Islands, Alaska

FAM. LESSONIACEAE

Dictyoneurum californicum Ruprecht

Scagel, 1957
Vancouver I., British Columbia ?, to San Luis Obispo Co., Calif.

Dictyoneuropsis reticulata (Saunders) G. M. Smith

Smith, 1944; Silva, 1957
Fort Ross; Monterey Peninsula, Calif.; northern Channel Islands

Nereocystis luetkeana (Mertens) Postels & Ruprecht

Scagel, 1957
Shumagin I., Alaska, to San Luis Obispo Co., Calif. (drift only to Santa Barbara)

Postelsia palmaeformis Ruprecht

Scagel, 1957
Hope I., British Columbia to San Luis Obispo Co., Calif.

Macrocystis integrifolia Bory

Womersley, 1954; Scagel, 1957
Sitka, Alaska, to Carmel, Calif.

Macrocystis pyrifera (Linnaeus) C. Agardh

Doty, 1947; Dawson, 1954, 1957, 1959*c*; North, 1959; Dawson, Neushul & Wildman, 1960
Sitka, Alaska, to Punta San Hipólito, Baja Calif., and sporadically to Isla Magdalena; Rocas Alijos

Pelagophycus porra (Leman) Setchell

Dawson, 1954; Dawson, Neushul & Wildman, 1960
Point Conception, Calif., to Islas San Benito, Baja Calif.

Lessoniopsis littoralis (Farlow & Setchell ex Tilden) Reinke

Scagel, 1957
Sitka, Alaska, to Carmel, Calif.

FAM. ALARIACEAE

Pterygophora californica Ruprecht

Dawson, 1954; Scagel, 1957
Southern British Columbia to Bahía del Rosario, Baja Calif.

Alaria dolichorhachis Kjellman

Okamura, 1933; Setchell & Gardner, 1925
Aleutian Islands, Alaska

Alaria fistulosa Postels & Ruprecht f. *fistulosa*

Okamura, 1933; Setchell & Gardner, 1925
Bering Sea to Wrangel, Alaska

Alaria fistulosa f. *platyphylla* Setchell

Setchell & Gardner, 1925
Bering Sea to southeastern Alaska

Alaria fistulosa f. *stenopylla* Setchell

Setchell & Gardner, 1925
Bering Sea to southeastern Alaska

Alaria lanceolata Kjellman

Setchell & Gardner, 1925
Bering Sea to Sitka, Alaska

Alaria marginata Postels & Ruprecht

Scagel, 1957
Northern British Columbia to Carmel, Calif.

Alaria nana Schrader

Scagel, 1957
Hope I., British Columbia to Carmel, Calif.

Alaria pylaii (Bory) Greville

Setchell & Gardner, 1925
Prince William Sound to Kodiak I., Alaska

Alaria tenuifolia Setchell f. *tenuifolia*

Okamura, 1933; Setchell & Gardner, 1925
Bering Sea to northern Wash.

Alaria tenuifolia f. *amplior* Setchell & Gardner

Scagel, 1957
Southern British Columbia to northern Wash.

Alaria valida Kjellman & Setchell f. *valida*

Scagel, 1957
Unga, Alaska, to Puget Sound, Wash.

Alaria valida f. *longipes* Setchell & Gardner

Scagel, 1957
Queen Charlotte Sound, British Columbia, to northern Wash.

Eisenia arborea Areschoug

Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Kyuquot Sound, Vancouver I., British Columbia; Redondo, Calif. to Isla Magdalena, Baja Calif.

Eisenia desmarestioides Setchell & Gardner

Dawson, 1954
Isla Guadalupe, Baja Calif.

Eisenia galapagensis Taylor

Taylor, 1945
Galapagos Arch.

Eisenia masonii Setchell & Gardner

Dawson, 1954
Isla Guadalupe, Baja Calif.

Egregia laevigata Setchell subsp. *laevigata*

Coe, 1932; Dawson, 1954, 1957 (as *E. australis* Hollenberg ms.), 1959*c*; Dawson, Neushul & Wildman, 1960; Silva, 1957
Goleta, Calif., to Punta San Eugenio, Baja Calif.; Rocas Alijos

Egregia laevigata subsp. *borealis* (Setchell) Silva

Silva, 1957
Santa Cruz to Gaviota, Calif.

Egregia menziesii (Turner) Areschoug subsp. *menziesii*

Scagel, 1957
Northern British Columbia to Point Conception, Calif.

Egregia menziesii subsp. *insularis* Silva

Silva, 1957
Northern Channel Islands, Calif.

ORDER FUCALES

FAM. FUCACEAE

Fucus distichus Linnaeus, emend Powell

Powell, 1957 (All species and subspecies of *Fucus* heretofore recognized from Pacific North America, with the exception of *F. parksii*, are considered by Powell as variants of *F. distichus*. Under subspecies *edentatus* he places *F. edentatus* De la Pylaie, *F. furcatus* C. Ag. (*F. gardneri* Silva), *F. nitens* Gard. and *F. evanescens* C. Ag., in part. Under subsp. *evanescens* he places *F. evanescens* C. Ag., in part. He considers *F. membranaceus* Gard. not sufficiently distinct even for subspecies status. See Dawson, 1946*a*, for a listing of the described forms, also Scagel, 1957 (various northern forms); Dawson, 1958 (as *F. furcatus*), 1959*c* (as *F. furcatus*)
Bering Sea to Government Point, Calif.

Fucus parksii Gardner

Gardner, 1940
Humbolt Bay; Eureka, Calif.

Pelvetia fastigiata (J. Agardh) G. De Toni f. *fastigiata*

Dawson, 1954; Scagel, 1957; Dawson, 1959*c*
Horswell Channel, British Columbia; Coos Bay, Oreg., to Punta Baja, Baja Calif.

Pelvetia fastigiata f. *gracilis* Setchell & Gardner

Smith, 1944; Dawson, 1954
Monterey Peninsula; Channel Islands, Calif.; northern Baja Calif.

Pelvetiopsis arborescens Gardner

Gardner, 1940
Point Carmel, Calif.

Pelvetiopsis limitata (Setchell) Gardner f. *limitata*

Scagel, 1957
Hope I., British Columbia, to Carmel, Calif.

Pelvetiopsis limitata f. *lata* Gardner

Smith, 1944
Tomales Point to Monterey, Calif.

Hesperophycus harveyanus (Decaisne) Setchell & Gardner

Dawson, 1954, 1959*c*
Santa Cruz, Calif., to Islas San Benito, Baja Calif.

FAM. SARGASSACEAE

Cystophora brandegeei (Setchell & Gardner) Dawson

Dawson, 1954, 1945*c*
La Jolla, Calif., to Isla Guadalupe, Baja Calif.

Cystophora galapagensis (Piccone & Grunow in Piccone) comb. nov.

Taylor, 1945 (as *Blossevillea galapagensis*); Piccone, 1886: 40 (as *Fucodium galapagense*)
Galapagos Arch.

Cystoseira geminata C. Agardh

Scagel, 1957
Bering Sea to northern Wash.

Cystoseira neglecta Setchell & Gardner

Dawson, 1954
Santa Catalina I., Calif., to Desembarcadero de Miller, Baja Calif.

Cystoseira osmundacea (Menzies) C. Agardh

Doty, 1947; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960.
Seaside, Oreg., to Punta Abreojos, Baja Calif.

Cystoseira setchellii Gardner

Setchell & Gardner, 1925
Redondo to San Diego, Calif.

Halidrys dioica Gardner

Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Redondo, Calif., to Isla Asunción, Baja Calif.

Sargassum acinacifolium Setchell & Gardner

Dawson, 1954
Puerto Libertad to Guaymas, Sonora

Sargassum agardhianum Farlow

Dawson, 1954, 1959*c*, 1960*a*; Dawson, Neushul & Wildman, 1960
Point Dume, Calif., to Punta Eugenio, Baja Calif.

Sargassum albemarlense Taylor

Taylor, 1945; Dawson, 1957
Galapagos Arch.

Sargassum brandegeei Setchell & Gardner

Taylor, 1945; Dawson, 1954, 1959
Puerto Libertad to Isla San Pedro Nolasco, Gulf of Calif.; Galapagos Arch.

Sargassum camouii Dawson

Dawson, 1954
Bahía Viscaino, Baja Calif.; east central Gulf of Calif.

Sargassum ecuadoreanum Taylor

Taylor, 1945
Vicinity of Guayas, Ecuador

Sargassum galapagense Grunow

Taylor, 1945
Galapagos Arch.

Sargassum herporhizum Setchell & Gardner

Dawson, 1954
Isla George; Isla San Pedro Mártir, Gulf of Calif.

Sargassum horridum Setchell & Gardner

Dawson, 1954, 1959
Southern Gulf of Calif.

Sargassum howellii Setchell & Gardner

Dawson, 1954
Revillagigedo Arch.

Sargassum johnstonii Setchell & Gardner f. *johnstonii*

Dawson, 1954
Punta Peñasco to Bahía Agua Verde, Gulf of Calif.

Sargassum johnstonii f. *gracile* Setchell & Gardner

Dawson, 1954
Punta Peñasco to Guaymas, Gulf of Calif.

Sargassum lapazeanum Setchell & Gardner

Dawson, 1954
Guaymas to La Paz, Gulf of Calif.

Sargassum liebmannii J. Agardh var. *liebmannii*

Dawson, 1954, 1957*b*
San Jose del Cabo, Baja Calif., to Bahía Honda, Panamá

Sargassum liebmannii var. *nicoyana* Grunow

Dawson, 1957*b*
Golfo de Nicoya, Costa Rica

Sargassum macdougalii Dawson

Dawson, 1954, 1959
Central and northern Gulf of Calif.

Sargassum muticum (Yendo) Fensholt

Scagel, 1957
Nanaimo, British Columbia, to Coos Bay, Oreg.

Sargassum pacificum Bory f. *pacificum*

Taylor, 1945; Dawson, 1957
Galapagos Arch.

Sargassum pacificum f. *congestum* Setchell

Taylor, 1945
Galapagos Arch.

Sargassum pacificum f. *rigidiusculum* (Grunow) Setchell

Taylor, 1945
Galapagos Arch.

Sargassum pacificum f. *megaphyllum* Taylor

Taylor, 1945
Galapagos Arch.

Sargassum palmeri Grunow

Dawson, 1954
Santa Cruz ?; Santa Catalina I., Calif., to Islas San Benito, Baja Calif.

Sargassum setifolium (Grunow) Setchell

Taylor, 1945; Dawson, 1957
Galapagos Arch.

Sargassum sinicola Setchell & Gardner

Dawson, 1954, 1959
Punta Peñasco to La Paz, Gulf of Calif.; Isla Guadalupe, Baja Calif.

Sargassum skottsbergii Sjoestedt, prox.

Taylor, 1945
Salinas, Ecuador

Sargassum sonorense Dawson

Dawson, 1960*a*
Northern Gulf of Calif.

Sargassum templetonii Setchell

Taylor, 1945; Dawson, Neushul & Wildman, 1960*a*
Isla Magdalena, Baja Calif.; Galapagos Arch.

Sargassum vizcainense Dawson

Dawson, 1954; Dawson, Neushul & Wildman, 1960*a*
Bahía Vizcaino and Isla Cedros to Punta Pequeña, Baja Calif.

Sargassum zacae Setchell

Taylor, 1945
Galapagos Arch.

PHYLUM **RHODOPHYCOPHYTA**

CLASS **RHODOPHYCEAE**

SUBCLASS **BANGIOPHYCIDAE**

ORDER **GONIOTRICHALES**

FAM. GONIOTRICHACEAE

Goniotrichum cornu-cervi (Reinsch) Hauck

Scagel, 1957
Friday Harbor, Wash.; Santa Cruz I., Calif.

Goniotrichum elegans (Chauvin) Zanardini

Taylor, 1945 (as *G. alsidii*); Dawson, 1954, 1957*b*; Scagel, 1957
Friday Harbor, Wash., to Isla Gorgona, Colombia

Goniotrichopsis sublittoralis G. M. Smith

Smith, 1944
Monterey, Calif.

ORDER **BANGIALES**

FAM. ERYTHROPELTIDACEAE

Smithora naiadum (Anderson) Hollenberg

Hollenberg, 1959; Dawson, Neushul & Wildman, 1960; Dawson, 1949*a* (as *Porphyra naiadum*); Scagel, 1957 (as *Porphyra naiadum*); Dawson, 1954 (as *Porphyra naiadum* var. *australis*), 1959*c* (as *Porphyra naiadum*)
Northern British Columbia to Isla Magdalena, Baja Calif.

Erythropeltis discigera (Berthold) Schmitz

Dawson, 1954
Isla Tiburón, Gulf of Calif.

Erythrotrichia ascendens Dawson

Dawson, 1954
Cabo Pulmo, southern Gulf of Calif.

Erythrotrichia biseriata Tanaka

Dawson, 1954, 1954*c*
Islas San Benito; Punta Abreojos, Baja Calif.; Gulf of Calif. to Mazatlán, Sinaloa; Isla San Benedicto, Revillagigedo Arch.

Erythrotrichia boryana (Montagne) Berthold

Dawson, 1954
Punta Baja to Bahía Asunción, Baja Calif.

Erythrotrichia californica Kylin

Smith, 1944; Dawson, 1954
Monterey, Calif.; Ensenada, Baja Calif.; Isla Tiburón, Gulf of Calif.

Erythrotrichia carnea (Dillwyn) J. Agardh

Smith, 1944; Dawson, 1954, 1957*b*, 1959*b*
Monterey, Calif., to Golfo Dulce, Costa Rica; Clipperton I.

Erythrotrichia ciliaris (Carmichael) Batters

Dawson, 1954
Punta Baja; Isla Cedros, Baja Calif.

Erythrotrichia kylinii Gardner

Scagel, 1957
Bering Sea to Puget Sound, Wash.

Erythrotrichia parksii Gardner var. *parksii*

Gardner, 1927
Eureka, Calif.

Erythrotrichia parksii var. *minor* Gardner

Scagel, 1957
Southern British Columbia to northern Wash.

Erythrotrichia polymorpha Howe

Taylor, 1945
Galapagos Arch.

Erythrotrichia porphyroides Gardner

Gardner, 1927
San Francisco, Calif.

Erythrotrichia pulvinata Gardner

Doty, 1947; Hollenberg, 1948; Dawson, 1954
Middle Bay, Oreg., to Bahía Asunción, Baja Calif.

Erythrotrichia tetraseriata Gardner

Dawson, 1954
San Pedro, Calif.; Isla Magdalena, Baja Calif.

Erythrotrichia welwitschii (Ruprecht) Batters

Doty, 1947
South Bay, Oreg.; Monterey, Calif.

Erythrocladia ectozoica Dawson

Dawson, 1954
Scammon Lagoon, Baja Calif.

Erythrocladia irregularis Rosenvinge

Dawson, 1954; Scagel, 1957
Northern Wash. to Monterey, Calif.; Isla Turner, Gulf of Calif.

Erythrocladia subintegra Rosenvinge

Dawson, 1954; Scagel, 1957
Northern Wash. to northern Baja Calif.; Gulf of Calif.

FAM. BANGIACEAE

Bangia enteromorphoides Dawson

Dawson, 1954
Mazatlán, Sinaloa

Bangia fuscopurpurea (Dillwyn) Lyngbye

Dawson, 1954, 1959*c*; Scagel, 1957
Northern British Columbia to Costa Rica

Bangia maxima Gardner

Gardner, 1927
Bolinas, Calif.

Bangia tenuis Gardner

Scagel, 1957
Orcas I., Wash.

Bangia vermicularis Harvey

Sanborn & Doty, 1946; Doty, 1947
Coos Bay, Oreg., to Carmel, Calif.

Porphyra abyssicola Kjellman

Scagel, 1957
Southern British Columbia to northern Wash.

Porphyra amplissima (Kjellman) Setchell & Hus

Scagel, 1957
Amaknak I., Alaska, to northern Wash.

Porphyra hollenbergii Dawson

Dawson, 1954, 1959
Southern Gulf of Calif.

Porphyra laciniata (Lightfoot) C. Agardh

Setchell & Gardner, 1903
Amaknak I. to Sitka, Alaska

Porphyra lanceolata (Setchell & Hus) G. M. Smith

Scagel, 1957
Chehalis Bay, Wash. to Carmel, Calif.

Porphyra miniata f. *cuneiformis* Setchell & Hus

Scagel, 1957
Gulf of Alaska to Monterey, Calif.

Porphyra nereocystis Anderson

Scagel, 1957
Uyak Bay, Alaska, to San Pedro, Calif.? (probably to San Luis Obispo Co.)

Porphyra occidentalis Setchell & Hus

Sanborn & Doty, 1946; Doty, 1947
Coos Bay, Oreg.; Carmel Bay, Calif.

Porphyra pendula Dawson

Dawson, 1954
Isla Partida; Isla Patos, Gulf of Calif.

Porphyra perforata J. Agardh f. *perforata*

Okamura, 1933; Dawson, 1954, 1959*c*; Scagel, 1957
Aleutian Islands, Alaska, to Isla Magdalena, Baja Calif.

Porphyra perforata f. *segregata* Setchell & Hus

Scagel, 1957
Southern British Columbia to northern Calif.

Porphyra pulchra Hollenberg

Smith, 1944
Santa Cruz to Monterey, Calif.

Porphyra schizophylla Hollenberg

Doty, 1947
Harris State Park; Otter Point, Oreg.; Pescadero Point, Calif.

Porphyra thuretii Setchell & Dawson, in Dawson

Doty, 1947; Dawson, 1954, 1959*c*
Chetco Cove, Oreg., to Isla Magdalena, Baja Calif.; Gulf of Calif.; Puerto Parker, Costa Rica

Porphyra tenuissima (Stroemfelt) Setchell & Hus

Setchell & Gardner, 1903
Shumagin I.; Yakutat Bay, Alaska

Porphyra umbilicalis (Linnaeus) Kützing

Scagel, 1957 (but with incorrect authorship)
St. Paul I., Alaska, to southern British Columbia

Porphyra variegata (Kjellman) Hus

Scagel, 1957
Southern British Columbia to Monterey, Calif.

Porphyrella californica Hollenberg

Hollenberg, 1945
Southern Calif.

Porphyrella gardneri Smith & Hollenberg

Hollenberg, 1945; Scagel, 1957
Northern British Columbia to Monterey, Calif.

Porphyropsis coccinea (J. Agardh) Rosenvinge

Scagel, 1957
Friday Harbor, Wash.

Conchocelis rosea Batters (probably represents a stage in the life cycle of one or more species of *Porphyra*)

Scagel, 1957
Northern Wash.

SUBCLASS FLORIDEOPHYCIDAE

ORDER NEMALIONALES

FAM. ACROCHAETIACEAE

Acrochaetium amphiroae (Drew) Papenfuss

Dawson, 1945*b* (as *Rhodochorton amphiroae*); Doty, 1947; Dawson, 1954
Oreg. to Isla Cedros, Baja Calif.

Acrochaetium angustum (Drew) Papenfuss

Papenfuss, 1945
Santa Catalina I., Calif.

Acrochaetium ascidiophilum Dawson

Dawson, 1954
Bahía San Quintín, Baja Calif.

Acrochaetium bonnemaisoniae (Batters) J. & G. Feldmann

Dawson, 1954
Punta San Quintín, Baja Calif.

Acrochaetium bornetii Papenfuss

Dawson, 1954
San Pedro, Calif.; Punta Pequeña, Baja Calif.

Acrochaetium coccineum (Drew) Papenfuss

Papenfuss, 1945
Marin Co.; San Francisco, Calif.

Acrochaetium daviesii (Dillwyn) Nägeli

Dawson, 1954; Dawson, Neushul & Wildman, 1960*a*
Carmel, Calif., to Isla Clarión, Revillagigedo Arch.

Acrochaetium densum (Drew) Papenfuss

Papenfuss, 1945
San Francisco, Calif.

Acrochaetium desmarestiae Kylin

Scagel, 1957
Northern Wash. to Oreg.

Acrochaetium dictyotae Collins

Papenfuss, 1945
San Diego Co., Calif.

Acrochaetium eastwoodae (Setchell & Gardner) Papenfuss
Dawson, 1954
Isla Clarión, Revillagigedo Arch.

Acrochaetium elegans (Drew) Papenfuss
Papenfuss, 1945
La Jolla, Calif.

Acrochaetium erythrophyllum Jao
Scagel, 1957
Port Angeles, Wash.

Acrochaetium gymnogongri (Drew) Papenfuss
Papenfuss, 1945
San Francisco, Calif.

Acrochaetium hancockii (Dawson) Papenfuss
Dawson, 1954
Isla Ángel de la Guarda, Gulf of Calif.

Acrochaetium infestans Howe & Hoyt
Dawson, 1960*a*
Puerto Culebra, Costa Rica

Acrochaetium macounii (Collins) Hamel
Scagel, 1957
Vancouver I., British Columbia, to Carmel Bay, Calif.

Acrochaetium magnificum (Drew) Papenfuss
Papenfuss, 1945
La Jolla, Calif.

Acrochaetium obscurum (Drew) Papenfuss
Papenfuss, 1945
Marin Co. to Carmel, Calif.

Acrochaetium pacificum Kylin
Dawson, 1954; Scagel, 1957; Dawson, Neushul & Wildman, 1960*a*
Northern Wash.; Oreg.; Islas San Benito, Baja Calif.; vicinity of Guaymas, Sonora

Acrochaetium penetrale (Drew) Papenfuss
Taylor, 1945; Dawson, 1954
La Jolla, Calif.; Bahía San Quintín, Baja Calif.; Puerto Parker, Costa Rica

Acrochaetium plumosum (Drew) G. M. Smith
Papenfuss, 1945; Dawson, 1954
Tomales Bay, Calif., to Bahía Asunción, Baja Calif.

Acrochaetium punctatum Dawson
Dawson, 1954
Bahía Bocochibampo, Sonora

Acrochaetium rhizoideum (Drew) Jao var. *rhizoideum*
Dawson, 1954; Scagel, 1957
Wash. to Isla Cedros, Baja Calif.

Acrochaetium rhizoideum var. *patens* (Drew) G. M. Smith
Smith, 1944
Carmel, Calif.

Acrochaetium scinaiae Dawson
Dawson, 1954
Santa Barbara I., Calif.; Gulf of Calif.

Acrochaetium simplex (Drew) Papenfuss
Papenfuss, 1945
Santa Monica, Calif.

Acrochaetium sinicolum (Dawson) Papenfuss
Dawson, 1954
Isla Turner, Gulf of Calif.

Acrochaetium spiculiphilum Dawson
Dawson, 1954
Bahía San Quintín, Baja Calif.

Acrochaetium subimmersum (Setchell & Gardner) Papenfuss
Scagel, 1957
Northern Wash. to Carmel, Calif.

Acrochaetium subseriatum Børgesen
Dawson, 1959*b*
Clipperton I.

Acrochaetium tenuissimum (Collins) Papenfuss
Papenfuss, 1945
San Pedro, Calif.

Acrochaetium thuretii var. *agama* (Rosenvinge) Dawson

Dawson, 1945*d*
San Pedro, Calif.

Acrochaetium vagum (Drew) Jao

Scagel, 1957
Northern Wash. to Moss Beach, Calif.

Acrochaetium variabile (Drew) G. M. Smith

Dawson, 1954; Scagel, 1957; Dawson, 1954*c*
Northern Wash. to Isla San Martín, Baja Calif.; Mazatlán, Sinaloa; Isla San Benedicto, Revillagigedo Arch.

Kylinia arcuata (Drew) Kylin

Dawson, 1954; Scagel, 1957
Cape Flattery, Wash., to Moss Beach, Calif.; Isla Turner, Gulf of Calif.

Kylinia crassipes (Børgesen) Kylin

Dawson, 1954
Bahía Vizcaino, Baja Calif.; Isla Rasa, Gulf of Calif. ?

Kylinia hirsuta (Drew) Kylin

Dawson, 1949; Scagel, 1957
Vancouver, British Columbia; Santa Catalina I., Calif.

Kylinia implicata (Drew) Papenfuss

Papenfuss, 1947
Moss Beach, Calif.

Kylinia microscopica (Nägeli) Kylin

Kylin, 1944; Papenfuss, 1945 (as *Chromastrum microscopicum*)
La Jolla, Calif.

Kylinia moniliformis (Rosenvinge) Kylin

Scagel, 1957
Vancouver I., British Columbia

Kylinia porphyrae (Drew) Papenfuss

Papenfuss, 1945 (as *Chromastrum porphyrae*); Dawson, 1954
San Francisco; Monterey, Calif.; Bahía San Quintín, Baja Calif.

Kylinia secundata (Lyngbye) Papenfuss

Dawson, 1954
Bahía Bocochibampo, Sonora

Kylinia seriaspora Dawson

Dawson, 1954
Isla Turner, Gulf of Calif.

Rhodochorton concrescens Drew

Papenfuss, 1945
Carmel Bay, Calif.

Rhodochorton penicilliforme (Kjellman) Rosenvinge

Scagel, 1957
Spruce I., Alaska, to San Juan Co., Wash.

Rhodochorton purpureum (Lightfoot) Rosenvinge

Dawson, 1954; Scagel, 1957
Bering Sea to Punta Eugenio, Baja Calif.

Rhodochorton tenue Kylin

Scagel, 1957
San Juan I., Wash.; Santa Cruz, Calif.

Audouinella membranacea (Magnus) Papenfuss

Scagel, 1957
San Juan Co., Calif.

FAM. HELMINTHOCLADIACEAE

Nemalion helminthoides (Velley) Batters

Dawson, 1954; Scagel, 1957; Dawson, 1959*c*, 1960*a*
Sitka, Alaska, to Isla Magdalena, Baja Calif.

Nemalion pulvinatum Grunow

Dawson, 1954
Bahía Agua Verde, Baja Calif.

Nemalion virens J. Agardh

Dawson, 1954
Cabeza Ballena, southern Baja Calif.; Pacific Mexico, probably Oaxaca

Helminthora saundersii Gardner

Smith, 1944
Monterey, Calif.

Helminthora stricta Gardner

Gardner, 1926
La Jolla, Calif.

Dermonema frappieri (Montagne & Millardet) Børgesen

Dawson, 1954, 1954*b*, 1954*c*, 1959
Isla San Benedicto, Revillagigedo Arch.; Isla Carmén, Gulf of Calif.; Mazatlán, Sinaloa

Helminthocladia californica (J. Agardh) Kylin

Dawson, 1954
Santa Barbara, Calif., to Punta Pequeña, Baja Calif.

Helminthocladia gracilis Gardner

Gardner, 1926
Santa Barbara, Calif.

Cumagloia andersonii (Farlow) Setchell & Gardner

Dawson, 1954; Scagel, 1957
Hope I., British Columbia, to Cabo Colnett, Baja Calif.

Liagora abbottae Dawson

Dawson, 1954
Punta Santa Rosalía, Baja Calif.

Liagora californica Zeh

Dawson, 1945*d*, 1954
Santa Catalina I., Calif., to Isla Guadalupe, Baja Calif.

Liagora ceranoides Lamouroux f. *ceranoides*

Taylor, 1945; Dawson, 1957*b*
Costa Rica

Liagora ceranoides f. *leprosa* (J. Agardh) Yamada

Dawson, 1954
Isla Guadalupe; Bahía Vizcaino, Baja Calif.

Liagora farinosa Lamouroux f. *farinosa*

Dawson, 1959
Southwestern Gulf of Calif.

Liagora farinosa f. *pinnatiramosa* Yamada

Dawson, 1954, 1957
Isla Guadalupe; Rocas Alijos, Baja Calif.

Liagora magniinvolucra Dawson

Dawson, 1954, 1959
Southwestern Gulf of Calif.

Liagora orientalis J. Agardh

Dawson, 1954
Bahía Vizcaino, Baja Calif.

Liagora valida Harvey

Dawson, 1957*b*
Golfo Dulce, Costa Rica

FAM. CHAETIANGIACEAE

Gloiophloea confusa Setchell

Dawson, 1954, 1959*c*, 1960*a*; Scagel, 1957; Taylor, 1945; Dawson, Neushul & Wildman, 1960; also see Levring, 1955
Vancouver I., British Columbia, to Punta María, Baja Calif.; Gulf of Calif.; Costa Rica; Galapagos Arch.

Scinaia articulata Setchell

Setchell, 1914*a*; Dawson, 1949
Santa Barbara I.; Santa Barbara, Calif.

Scinaia complanata (Collins) Cotton

Taylor, 1945
Puerto Culebra, Costa Rica; Galapagos Arch.

Scinaia johnstoniae Setchell

Taylor, 1945; Dawson, 1954; Dawson, Neushul & Wildman, 1960
Southern Calif. to Costa Rica; Gulf of Calif.; Galapagos Arch.

Scinaia latifrons Howe

Taylor, 1945; Dawson, 1954, 1953, 1960*a*
Southern Calif. to Puerto Guatulco, Oaxaca; Gulf of Calif.; Galapagos Arch.

Scinaia minima Dawson

Dawson, 1954
Isla Cedros, Baja Calif.

Scinaia setchellii Taylor

Taylor, 1945
Galapagos Arch.

Pseudoscinaia snyderae Setchell

Setchell, 1914*a*; Dawson, 1945*b*
San Pedro to San Diego, Calif.

Whidbeyella cartilaginea Setchell & Gardner

Scagel, 1957
Whidbey I., Wash.

Galaxaura angustifrons Kjellman

Taylor, 1945
Galapagos Arch.

Galaxaura arborea Kjellman

Dawson, 1954, 1959
Bahía Santa María, Baja Calif.; southern Gulf of Calif.

Galaxaura barbata Chou

Taylor, 1945
Galapagos Arch.

Galaxaura fastigiata Decaisne

Dawson, 1954, 1959
Isla Guadalupe; Bahía Vizcaino, Baja Calif.; Gulf of Calif.; Isla María Madre, Nayarit

Galaxaura filamentosa Chou

Taylor, 1945; Dawson, 1954, 1957*b*
Isla Clarión, Revillagigedo Arch.; Costa Rica; Galapagos Arch.

Galaxaura intermedia Chou

Taylor, 1945
Galapagos Arch.

Galaxaura marginata Lamouroux

Farlow, 1902
Galapagos Arch.

Galaxaura oblongata (Ellis & Solander) Lamouroux

Taylor, 1945
Esmeraldas, Ecuador

Galaxaura ramulosa Kjellman

Taylor, 1945; Dawson, 1957*b*
Golfo Dulce, Costa Rica; Isla Jicarita, Panamá

Galaxaura spathulata Kjellman

Taylor, 1945
Galapagos Arch.

Galaxaura squalida Kjellman

Taylor, 1945; Dawson, 1954
Southeasternmost Baja Calif.; Bahía Honda, Panamá

Galaxaura stupocaula Chou

Dawson, 1957*b*
Costa Rica

Galaxaura subfruticulosa Chou

Dawson, 1954
Punta Palmilla, Baja Calif. del Sur; Isla Clarión, Revillagigedo Arch.

Galaxaura veprecula Kjellman

Taylor, 1945; Dawson, 1954, 1957*b*, 1959
Southern Gulf of Calif.; Costa Rica; Galapagos, Arch.

FAM. BONNEMAISONIACEAE

Bonnemaisonia nootkana (Esper) Silva

Scagel, 1957
Northern British Columbia to Santa Rosa I., Calif.

Bonnemaisonia geniculata Gardner

Smith, 1944
Carmel Bay to Point Sur, Calif.

Bonnemaisonia hamifera Hariot

Feldmann & Feldmann, 1942; Dawson, 1954 (both as the gametophyte generation of *Trailliella intricata*); Kylin, 1941 (as *Asparagopsis hamifera*); Silva, 1957*a* (as *Bonnemaisonia intricata*, the alternate generation of *Trailliella intricata*)
Santa Rosa I., Calif., to Punta San Quintín, Baja Calif.

Trailliella intricata Batters

Scagel, 1957 (as sporophyte generation of *Bonnemaisonia*)
Northern Wash. to central Baja Calif.

Asparagopsis taxiformis (Delile) Collins & Hervey

Dawson, 1954, 1957, 1959 (as the gametophyte generation of *Falkenbergia hillebrandii*)

Isla Guadalupe; central Baja Calif.; Rocas Alijos; Revillagigedo Arch.; Gulf of Calif.; Isla Salango, Ecuador; Galapagos Arch.

Asparagopsis svedelii Taylor

Taylor, 1945

Galapagos Arch.

Falkenbergia hillebrandii (Bornet) Falkenberg

Dawson, 1954 (as the sporophyte generation of *Asparagopsis taxiformis*)

Isla Guadalupe; Bahía Vizcaino, Baja Calif.; Miramar, Nayarit; Puerto Marqués, Guerrero

ORDER GELIDIALES

FAM. GELIDIACEAE

Gelidium arborescens Gardner

Smith, 1944

Monterey to Cambria, Calif.

Gelidium cartilagineum var. *robustum* Gardner

Scagel, 1957; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960

Southern British Columbia to Isla Magdalena, Baja Calif.

Gelidium contortum Loomis

Loomis, 1960

San Francisco; Topanga, Calif.

Gelidium coronadense Dawson

Dawson, 1954

Islas Los Coronados, Baja Calif.

Gelidium coulteri Harvey

Sanborn & Doty, 1946; Doty, 1947; Dawson, 1954, 1959*c*

Coos Bay, Oreg., to Isla Magdalena, Baja Calif.

Gelidium crinale (Turner) Lamouroux var. *crinale*

Dawson, 1954, 1959*c*; Scagel, 1957; Taylor, 1945

Southern British Columbia to Isla Magdalena, Baja Calif.; Gulf of Calif.; Mazatlán, Sinaloa; Galapagos Arch.

Gelidium crinale var. *luxurians* Collins

Gardner, 1927*e*; Dawson, 1954

Southern Calif. to Punta Baja, Baja Calif.

Gelidium deciduum Dawson

Dawson, 1954

Cabeza Ballena, near San Lucas, Baja Calif.

Gelidium densum Gardner

Gardner, 1927*e*; Dawson, 1959*c*

Montecito; San Pedro, Calif.

Gelidium distichum Loomis

Loomis, 1949

Redondo, Calif.

Gelidium filicinum Bory

Taylor, 1945

Galapagos Arch.

Gelidium gardneri Loomis

Loomis, 1960

Santa Monica Bay, Calif.

Gelidium galapagense Taylor

Taylor, 1945

Galapagos Arch.

Gelidium hancockii Taylor

Taylor, 1945 (probably the *G. serrulatum* of Farlow, 1902)

Galapagos Arch.

Gelidium isabelae Taylor

Taylor, 1945

Bahía Utria, Colombia; Galapagos Arch.

Gelidium johnstonii Setchell & Gardner

Dawson, 1954, 1959

Punta Santa Rosalía; Isla Magdalena, Baja Calif.; Gulf of Calif.

Gelidium microdentatum Dawson

Dawson, 1960*a*
San Blas, Nayarit

Gelidium microphysa Setchell & Gardner

Dawson, 1954
Isla Guadalupe; Isla Cedros, Baja Calif.; northern Gulf of Calif.

Gelidium nudifrons Gardner

Dawson, 1954; Dawson, Neushul & Wildman, 1960, 1960*a*
Southern Calif. to Bahía Tortuga, Baja Calif.

Gelidium papenfussii Loomis

Dawson, 1954
San Francisco; Santa Monica, Calif.; Punta Baja; Punta Santa Rosalía, Baja Calif.

Gelidium polystichum Gardner

Dawson, 1949, 1954
San Pedro; Santa Catalina I., Calif.; Isla Guadalupe, Baja Calif.

Gelidium pulchrum Gardner

Kylin, 1941; Sanborn & Doty, 1946; Doty, 1947; Dawson, 1954, 1959*c*
Coos Bay, Oreg., to Bahía Rosario, Baja Calif.

Gelidium purpurascens Gardner

Smith, 1944; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Bolinas, Calif., to Cabo Colnett, Baja Calif.

Gelidium pusillum (Stackhouse) Le Jolis var. *pusillum*

Smith, 1944; Doty, 1947; Dawson, 1954, 1954*c*, 1957*b*, 1959
Oreg. to Panamá

Gelidium pusillum var. *cylindricum* Taylor

Taylor, 1945; Dawson, 1953
Pacific Mexico; Esmeraldas, Ecuador

Gelidium pusillum var. *pacificum* Taylor

Taylor, 1945
Galapagos Arch.

Gelidium pusillum var. *minusculum* Weber van Bosse

Dawson, 1953
Pacific Mexico

Gelidium pusillum var. *mucronatum* Dangeard

Dawson, 1953
Pacific Mexico

Gelidium pusillum var. *conchicola* Piccone & Grunow

Dawson, 1953
Pacific Mexico

Gelidium pusillum var. *pulvinatum* (C. Agardh) Feldmann

Dawson, 1953
Pacific Mexico

Gelidium ramuliferum Gardner

Gardner, 1927*e*; Dawson, 1959*c*
Santa Barbara; San Pedro, Calif.

Gelidium sclerophyllum Taylor

Taylor, 1945; Dawson, 1954, 1957*b*
Isla Clarión, Revillagigedo Arch.; southern Baja Calif. to Golfo Dulce, Costa Rica; Esmeraldas; Guayas, Ecuador

Gelidium setchellii Gardner

Gardner 1927*e*
Marin Co., Calif.

Gelidium sinicola Gardner

Doty, 1947; Smith, 1944
South Bay, Oreg.; San Francisco Bay; Monterey, Calif.

Gelidium ? sonorense Dawson

Dawson, 1954
Near Guaymas, Sonora

Gelidium undulatum Loomis

Loomis, 1960
Redondo, Calif.

Gelidium venturianum Dawson

Dawson, 1958
Mussel Shoals, Ventura Co., Calif.

Pterocladia caloglossoides (Howe) Dawson

Dawson, 1954; Dawson, Neushul & Wildman, 1960*a*; Doty, 1947 (as *Gelidium caloglossoides*); Smith, 1944 (as *Gelidium caloglossoides*)

Oreg. ?; Monterey Peninsula, Calif. ?; Southern Calif. to Isla Asunción, Baja Calif.; Barra de Navidad, Jalisco

Pterocladia complanata Loomis

Dawson, 1954

Anaheim Landing, Calif.; Punta Descanso; Punta Eugenio, Baja Calif.

Pterocladia media Dawson

Dawson, 1958

La Jolla, Calif.

Pterocladia mcnabbiana Dawson

Dawson, 1957*b*

Golfo Dulce, Costa Rica

Pterocladia musciformis Taylor

Dawson, 1957*b*, 1960*a*

Bahía Carrizal, Colima; Golfo Dulce, Costa Rica

Pterocladia parva Dawson

Dawson, 1954

San Felipe, Gulf of Calif.

Pterocladia pyramidale (Gardner) Dawson

Dawson, 1954, 1954*c*, 1957, 1959 (as probably including *Gelidium decompositum*), 1959*c*; Dawson, Neushul & Wildman, 1960

Southern Calif. to Isla Magdalena, Baja Calif.; Isla Guadalupe; Rocas Alijos; Revillagigedo Arch.; central Gulf of Calif.; Galapagos Arch.; vicinity of Guayas, Ecuador

Gelidiocolax microsphaerica Gardner

Dawson, 1954; Fan & Papenfuss, 1959

Balboa, Calif.; Punta Descanso; Isla San Martín, Baja Calif.

FAM. GELIDIELLACEAE

Gelidiella acerosa (Forsskål) Feldmann & Hamel

Dawson, 1954

Southern Gulf of Calif. to Central America

Gelidiella adnata Dawson

Dawson, 1954*c*

Isla San Benedicto, Revillagigedo Arch.

Gelidiella hancockii Dawson

Dawson, 1954, 1959, 1960*a*

Bahía Magdalena, Baja Calif.; Gulf of Calif.; Isla del Caño, Costa Rica; Isla del Rey, Panamá

Gelidiella ligulata Dawson

Dawson, 1954

Southeasternmost Baja Calif.

Gelidiella machrisiana Dawson

Dawson, 1957*b*

Golfo de Nicoya, Costa Rica

Gelidiella ? refugiensis Dawson

Dawson, 1954

Isla Ángel de la Guarda; Bahía San Carlos ?, Gulf of Calif.

Gelidiella stichidiospora Dawson

Dawson, 1954

Isla Cedros, Baja Calif.

Gelidiella pannosa (Feldmann) Feldmann & Hamel

Dawson, 1957*b* (as *G. tenuissima*)

Costa Rica

OF UNCERTAIN FAMILY POSITION

Wurdemannia miniata (Draparnaud) Feldmann & Hamel

Dawson, 1954, 1957*b*

Puerto San Carlos, Gulf of Calif. to Panamá

ORDER CRYPTONEMIALES

FAM. DUMONTIACEAE

Dudresnaya colombiana Taylor

Taylor, 1945
Isla Gorgona, Colombia

Cryptosiphonia woodii (J. Agardh) J. Agardh

Scagel, 1957; Dawson, 1959*c*
Unalaska, Alaska, to Venice, Calif.

Thuretellopsis peggiana Kylin

Scagel, 1957
Friday Harbor, Wash.

Dumontia filiformis (Lyngbye) J. Agardh

Setchell & Gardner, 1903
Alaska

Baylesia plumosa Setchell

Smith, 1944
Santa Cruz; Monterey, Calif.

Pikea californica Harvey

Dawson, 1954, Scagel, 1957
Southern British Columbia to Punta Baja, Baja Calif.

Pikea pinnata Setchell

Scagel, 1957
Northern Wash. to Coronado, Calif.

Farlowia compressa J. Agardh

Scagel, 1957
Northern Wash. to Carmel, Calif.

Farlowia mollis (Harvey & Bailey) Farlow & Setchell

Scagel, 1957; Doty, 1947 (as including *F. crassa*); Dawson, 1959*c* (as *F. crassa*)
Dixon Harbor, Alaska, to San Diego, Calif.

Dilsea californica (J. Agardh) Schmitz

Scagel, 1957
Unga I., Alaska, to San Francisco, Calif.

Dilsea integra (Kjellman) Rosenvinge

Setchell & Gardner, 1903 (as *Sarcophyllis arctica*)
Alaska

Leptocladia binghamiae J. Agardh

Setchell, 1912; Kylin, 1941; Dawson, 1954; Dawson, Neushul & Wildman, 1960; Taylor, 1945
Santa Cruz, Calif., to Isla Magdalena, Baja Calif.; Galapagos Arch.

Leptocladia conferta Setchell

Smith, 1944; Doty, 1947 (as *Pikea nootkana*)
Crescent City to Carmel Bay, Calif.

Weeksia fryeana Setchell

Scagel, 1957
Northern Wash.

Weeksia howellii Setchell & Gardner

Dawson, 1954
Isla Natividad, Baja Calif.

Weeksia reticulata Setchell

Smith, 1944; Dawson, 1945*e* (but the determination erroneous)
Monterey Peninsula, Calif.

Weeksia templetonii Setchell & Gardner

Dawson, 1954
Santa Cruz I., Calif.; Isla Cedros, Baja Calif.

Constantinea rosa-marina (Gmelin) Postels & Ruprecht

Setchell & Gardner, 1903; Setchell, 1906
Western Aleutian Islands to Sitka, Alaska

Constantinea simplex Setchell

Scagel, 1957
Northern British Columbia to Carmel, Calif.

Constantinea subulifera Setchell

Scagel, 1957
Northern British Columbia to northern Wash.

FAM. RHIZOPHYLLIDACEAE

Ochtodes crockeri Setchell & Gardner

Taylor, 1945; Dawson, 1957
Galapagos Arch.

FAM. GLOIOSIPHONIACEAE

Gloiosiphonia californica (Farlow) J. Agardh
Dawson, 1954; Scagel, 1957; Dawson, 1958
Sitka, Alaska, to Punta Baja, Baja Calif.

Gloiosiphonia capillaris (Hudson) Carmichael
Scagel, 1957
Southern British Columbia

Gloiosiphonia verticillaris Farlow
Scagel, 1957
Sitka, Alaska, to Carmel Bay, Calif.

FAM. ENDOCLADIACEAE

Gloiopeltis furcata (Postels & Ruprecht) J. Agardh
Scagel, 1957
Aleutian Islands, Alaska, to Oreg.

Gloiopeltis minuta Kylin
Kylin, 1941; Dawson, 1954
Santa Catalina I., Calif.; Islas San Benito; Punta Eugenio, Baja Calif.

Endocladia muricata (Postels & Ruprecht) J. Agardh
Okamura, 1933; Dawson, 1954, 1959*c*; Scagel, 1957
Aleutian Islands, Alaska, to Punta Santo Tomás, Baja Calif.

FAM. SQUAMARIACEAE

Ethelia mexicana Dawson
Dawson, 1954
Acapulco, Guerrero

Peyssonelia clarionensis Taylor
Taylor, 1945; Dawson, 1954
Isla Clarión, Revillagigedo Arch.; Galapagos Arch.

Peyssonelia conchicola Piccone & Grunow
Dawson, 1954, 1957*b*
Bahía San Lucas, Baja Calif.; Golfo Dulce, Costa Rica

Peyssonelia guadalupensis Dawson
Dawson, 1954
Isla Guadalupe, Baja Calif.

Peyssonelia mexicana Dawson
Dawson, 1954
Cabo Colnett, Baja Calif.; Acapulco, Guerrero

Peyssonelia pacifica Kylin
Dawson, 1954; Scagel, 1957
San Juan I., Wash., to Isla Cedros, Baja Calif.; Mazatlán, Sinaloa

Peyssonelia rubra var. *orientalis* Weber van Bosse
Dawson, 1954, 1957, 1959; Dawson, Neushul & Wildman, 1960
Southern Calif. Channel Islands to Miramar, Nayarit; Revillagigedo Arch.; Galapagos Arch.

Peyssonelia squamaria (Gmelin) Decaisne
Dawson, 1954
San Jose del Cabo, Baja Calif.

Cruoriella dubyi (Crouan & Crouan) Schmitz
Dawson, 1954, 1959*c*, 1960*a*
La Jolla, Calif., to Isla Brincanco, Panamá

Cruoriella fissurata Dawson
Dawson, 1954, 1957*b*, 1960*a*
Guaymas, Sonora, to Isla del Rey, Panamá

Cruoriella hancockii Dawson
Dawson, 1954, 1960*a*
Islas San Benito, Baja Calif., to Bahía Santiago, Colima

Cruoriella magdalenae Dawson
Dawson, 1954
Punta Eugenio; Isla Magdalena, Baja Calif.

Rhododermis elegans Crouan
Smith, 1944; Hollenberg, 1948
Marin Co. to Monterey, Calif.

Rhododermis georgii (Batters) Collins
Doty, 1947
Cape Arago, Oreg. ?

Asymmetria expansa (Setchell & Gardner) Setchell & Gardner
Smith, 1944
Monterey, Calif.

FAM. HILDENBRANDIACEAE

Hildenbrandia canariensis var. *dawsonii* Ardré
Ardré, 1959; Dawson, 1954 (as *H. prototypus* var. *kerguelensis*); Dawson, Neushul & Wildman, 1960*a*
Central Baja Calif.

Hildenbrandia galapagensis Setchell & Gardner
Setchell & Gardner, 1937
Galapagos Arch.

Hildenbrandia occidentalis Setchell
Taylor, 1945; Scagel, 1957; Dawson, Neushul & Wildman, 1960*a*
Northern British Columbia to Isla San Gerónimo, Baja Calif.; Galapagos Arch.

Hildenbrandia prototypus Nardo
Taylor, 1945; Dawson, 1954, 1954*c*, 1957*b*, 1959, 1959*c*; Scagel, 1957 (in part as *H. rosea*)
Alaska to Panamá; Galapagos Arch.

FAM. CORALLINACEAE

Archeolithothamnium crosslandi Lemoine
Taylor, 1945
Galapagos Arch.

Archaeolithothamnium howei Lemoine
Lemoine, 1929; Dawson, 1960*a*
Isla Coiba, Panamá

Archaeolithothamnium zonatosporum Foslie
Foslie, 1906; Dawson, 1960*a*
Long Beach, Calif. ?

Sporolithon pacificum Dawson
Dawson, 1960*a*
Isla del Caño, Costa Rica

Melobesia galapagensis (Foslie) Taylor
Taylor, 1945
Galapagos Arch.

Melobesia marginata Setchell & Foslie
Scagel, 1957; Dawson, 1959*c*, 1960
Southern British Columbia to Bahía Vizcaino, Baja Calif.; southern Gulf of Calif.; Revillagigedo Arch.; Costa Rica

Melobesia mediocris (Foslie) Setchell & Mason
Scagel, 1957; Dawson, 1959*c*, 1960; Dawson, Neushul & Wildman, 1960
Northern British Columbia to Isla Magdalena, Baja Calif.

Melobesia membranacea (Esper) Lamouroux
Dawson, 1960
Cabeza Ballena, Baja Calif.; Isla San Benedicto, Revillagigedo Arch.

Melobesia polystromatica Dawson
Dawson, 1960
Bahía Tenacatita, Jalisco

Lithothamnium aculeiferum L. Mason
Dawson, 1960
Duxbury Reef, Calif., to Scammon Lagoon, Baja Calif.

Lithothamnium australe (Foslie) Foslie
Dawson, 1960
Isla Guadalupe, Baja Calif., to Bahía Honda, Panamá. Gulf of Calif.; Revillagigedo Arch.

? *Lithothamnium bisporum* Foslie
Dawson, 1949
Santa Catalina I., Calif.

Lithothamnium californicum Foslie
Scagel, 1957; Dawson, 1959*c*, 1960
Southern British Columbia to Isla Magdalena, Baja Calif.

Lithothamnium cottoni Lemoine
Taylor, 1945
Galapagos Arch.

Lithothamnium fruticulosum (Kützing) Foslie
Dawson, 1960; Dawson & Beaudette, 1960
Bodega Bay, Calif., to Bahía Uvita, Costa Rica; Islas Revillagigedos; southern Gulf of Calif.

Lithothamnium giganteum L. Mason

Dawson, 1960; Dawson, Neushul & Wildman, 1960
Southern Calif. to central Baja Calif.; Bahía Petatlán, Guerrero; Corinto, Nicaragua ?

Lithothamnium guadalupensis Dawson

Dawson, 1960
Isla Guadalupe, Baja Calif.

Lithothamnium heteromorphum (Foslie) Foslie

Dawson, 1957*b*
Golfo de Nicoya, Costa Rica ?

? *Lithothamnium laeve* (Strömfelt) Foslie

Dawson, 1960
Vicinity of Isla Cedros, Baja Calif.

Lithothamnium lamellatum Setchell & Foslie

Smith, 1944; Doty, 1947; Dawson, 1960; Dawson, Neushul & Wildman, 1960
Oreg. to central Baja Calif.

Lithothamnium lenormandii (Areschoug) Foslie

Dawson, 1960
Throughout Pacific Baja Calif.; northern Gulf of Calif.; Bahía Santiago, Colima; Puerto Guatulco, Oaxaca

Lithothamnium montereyicum Foslie

Smith, 1944; Dawson, 1949; Mason, 1953; Dawson, 1960 (as possibly a form of *L. australe*)
Monterey; Anacapa I., Calif.

Lithothamnium muricatum (Foslie) G. De Toni

Scagel, 1957
Port Renfrew, British Columbia

Lithothamnium pacificum (Foslie) Foslie

Scagel, 1957; Dawson, 1960; Taylor, 1945
Vancouver I., British Columbia, to La Jolla, Calif.; Isla Grande, Guerrero ?; Galapagos Arch. ?

Lithothamnium phymatodeum Foslie

Scagel, 1957
Whidbey I., Wash., to Pacific Grove, Calif.

Lithothamnium pocillum Lemoine

Taylor, 1945
Galapagos Arch.

Lithothamnium volcanum Dawson

Dawson, 1960
Santa Cruz I., Calif.; Cortez Bank; Isla Magdalena, Baja Calif.

Polyporolithon conchatum (Setchell & Foslie) L. Mason

Scagel, 1957
Southern British Columbia to Cambria, Calif.

Polyporolithon parcum (Setchell & Foslie) L. Mason

Scagel, 1957
San Juan I., Wash., to Carmel, Calif.

Polyporolithon reclinatum (Foslie) L. Mason

Scagel, 1957
Vancouver I., British Columbia, to La Jolla, Calif.

Clathromorphum compactum (Kjellman) Foslie

Mason, 1953
St. Michael, Norton Sound, Alaska

Clathromorphum circumscriptum (Strömfelt) Foslie

Mason, 1953
Aleutian I. to Unalaska, Alaska

Hydrolithon arenicolum Dawson

Dawson, 1960
Scammon Lagoon, Baja Calif.

Hydrolithon conicum Dawson

Dawson, 1960
Isla Socorro, Revillagigedo Arch.

Hydrolithon reinboldii (Weber van Bosse & Foslie) Foslie

Dawson, 1960
Revillagigedo Arch.

Hydrolithon setchellii (Foslie) Setchell & L. Mason

Dawson, 1960
Redondo to La Jolla, Calif.; Isla Guadalupe, Baja, Calif.

Fosliella farinosa (Lamouroux) Howe

Dawson, 1960
Isla Guadalupe; southern Baja Calif.; Islas Tres Marías to Acapulco, Guerrero

Fosliella (?) *minuta* Taylor

Taylor, 1945
Bahía Honda, Panamá; Guayas, Ecuador

Fosliella paschalis (Lemoine) Setchell & Gardner

Dawson, 1959*b*, 1960
Isla Guadalupe, Baja Calif.; Isla Ildefonso; Punta Palmilla, Gulf of Calif.; Clipperton I.

Goniolithon tessellatum (Lemoine) Setchell & L. Mason

Setchell & Mason, 1943; Dawson, 1960*a*
Islas Contreras, Panamá; Galapagos Arch.

Dermatolithon canescens (Foslie) Foslie

Dawson, 1957*b*, 1960
Isla Guadalupe; Bahía Vizcaino, Baja Calif.; central Gulf of Calif.; Mazatlán, Sinaloa; Costa Rica

Dermatolithon corallinae (Crouan & Crouan) Foslie

Dawson, 1960
Santa Catalina I., Calif.; Cabeza Ballena, Baja Calif.; Bahía Tenacatita, Jalisco

Dermatolithon dispar (Foslie) Foslie

Scagel, 1957; Dawson, 1960; Dawson, Neushul & Wildman, 1960
Northern Wash. to La Jolla, Calif.; Cabeza Ballena, Baja Calif.; near Guaymas, Sonora

Dermatolithon pustulatum (Lamouroux) Foslie f. *pustulatum*

Dawson, 1957
Galapagos Arch.

Dermatolithon pustulatum f. *ascripticium* (Foslie) Foslie ex De Toni

Dawson, 1959*c* (as *D. ascripticium*), 1960; Taylor, 1945 (as *Lithophyllum mutabile*)
Coos Bay, Oreg., to Bahía Ballena, Costa Rica; Revillagigedo Arch.; Galapagos Arch.

Dermatolithon saxicolum (Lemoine) Setchell & L. Mason

Setchell & Mason, 1943
Isla Cocos, Costa Rica

Dermatolithon veleroae Dawson

Dawson, 1960
Bahía Agua Verde, Baja Calif.

Tenarea erecta Lemoine

Taylor, 1945
Galapagos Arch.

Porolithon castellum Dawson

Dawson, 1960*a*
Isla del Caño, Costa Rica

Porolithon cocosicum Lemoine

Lemoine, 1929
Isla Cocos, Costa Rica

Porolithon oncodes (Heydrich) Foslie

Dawson, 1959*b*, 1960*a*
Isla del Caño, Costa Rica; Clipperton I.

Porolithon marshallense Taylor

Dawson, 1959*b*
Clipperton I. ?

Porolithon sonorense Dawson

Dawson, 1960
Bahía Vizcaino, Baja Calif.; northern Gulf of Calif.

Mesophyllum laxum Lemoine

Taylor, 1945
Galapagos Arch.

Lithophyllum alternans Lemoine

Taylor, 1945
Galapagos Arch.

Lithophyllum amplostratum Taylor

Taylor, 1945
Galapagos Arch.

Lithophyllum (?) *coibense* Lemoine

Lemoine, 1929
Isla Coiba, Panamá

Lithophyllum complexum Lemoine

Taylor, 1945
Galapagos Arch.

Lithophyllum decipiens Foslie

Scagel, 1957; Dawson, 1957*b*, 1959*c*, 1960
Northern British Columbia to Guaymas, Sonora; Revillagigedo Arch.; Costa Rica ?; Islas Perlas, Panamá

Lithophyllum sp. aff. *L. detrusum* Foslie

Dawson, 1960
Isla Cedros, Baja Calif.

Lithophyllum diguetii (Hariot) Heydrich

Dawson, 1960
Isla Ángel de la Guarda; vicinity of La Paz, Gulf of Calif.

Lithophyllum (?) *divaricatum* Lemoine

Taylor, 1945; Dawson, 1960
Galapagos Arch.

Lithophyllum farlowii Heydrich

Taylor, 1945
Galapagos Arch.

Lithophyllum (?) *fetum* Foslie

Lemoine, 1929
Isla Cocos, Costa Rica

Lithophyllum frutescens (Foslie) Lemoine f. *frutescens*

Taylor, 1945 (possibly the *Lithothamnium calcareum* of Harvey, 1847)
Galapagos Arch.

Lithophyllum frutescens f. *galapagense* Foslie

Taylor, 1945
Galapagos Arch.

Lithophyllum grumosum (Foslie) Foslie

Smith, 1944; Doty, 1947; Dawson, 1960
Capa Arago, Oreg. ?, to Bahía Vizcaino, Baja Calif.; Isla San Benedicto, Revillagigedo Arch.

Lithophyllum hancockii Dawson

Dawson, 1960
Isla Espíritu Santo, Gulf of Calif.

Lithophyllum imitans Foslie

Dawson, 1960; Dawson, Neushul & Wildman, 1960
Moss Beach, Calif., to central Baja Calif.; Gulf of Calif.; Revillagigedo Arch.; Puerto Guatulco, Oaxaca

Lithophyllum intermedium Foslie

Taylor, 1945
Galapagos Arch.

Lithophyllum lichenare L. Mason

Scagel, 1957; Dawson, 1960
Kanaka Bay, Wash.; Farnsworth Bank, so. Calif.; Punta Banda, Baja Calif.

Lithophyllum lithophylloides Heydrich

Dawson, 1960
Gulf of Calif.; Isla Clarión, Revillagigedo Arch.

Lithophyllum (?) *lividum* Lemoine

Lemoine, 1929
Isla Cocos, Costa Rica

Lithophyllum margaritae (Hariot) Heydrich

Dawson, 1960
Vicinity of La Paz, Gulf of Calif.

Lithophyllum moluccense var. *geminostratum* Taylor

Taylor, 1945
Galapagos Arch.

Lithophyllum neofarlowii Setchell & L. Mason

Scagel, 1957; Dawson, 1960
San Juan Islands, Wash., to Cambria, Calif.; Bahía Asunción, Baja Calif.

Lithophyllum pallescens (Foslie) Heydrich

Dawson, 1960
Southern Gulf of Calif.; Islas Contreras, Panamá

Lithophyllum proboscidium Foslie var. *proboscidium*

Dawson, 1960
Bodega Bay, Calif., to Punta Santa Rosalía, Baja Calif.; vicinity of Guaymas, Sonora; Barra de Navidad, Jalisco; Acapulco, Guerrero

Lithophyllum proboscideum var. *delicatulum* Dawson

Dawson, 1960
Isla Guadalupe, Baja Calif.

Lithophyllum (?) *propinquum* var. *cocosica* Lemoine

Lemoine, 1929
Isla Cocos, Costa Rica

Lithophyllum reesei Dawson

Dawson, 1960
Punta Banda, Baja Calif.

Lithophyllum rileyi Lemoine

Taylor, 1945 (as probably equal to the *Lithothamnium crassum* of Piccone, 1889)
Galapagos Arch.

Lithophyllum samoense Foslie

Dawson, 1960
Isla Cedros, Baja Calif.

Lithophyllum sancti-georgei Lemoine

Taylor, 1945
Galapagos Arch.

Lithophyllum trichotomum (Heydrich) Lemoine

Dawson, 1957, 1960
Revillagigedo Arch.; Gulf of Calif. to Isla Jicarón, Panamá; Galapagos Arch.

Lithophyllum veleroae Dawson

Dawson, 1960
Isla Espíritu Santo; vicinity of Santa Rosalía, Gulf of Calif.

Lithophyllum whidbeyense Foslie

Scagel, 1957
Southern British Columbia to northern Wash.

Heteroderma corallinicola Dawson

Dawson, 1960
Guaymas, Sonora

Heteroderma gibbsii (Foslie & Setchell) Foslie

Dawson, 1960
Gulf of Calif.

Heteroderma lejolisii (Rosanoff) Foslie

Dawson, 1960
Bahía San Quintín, Baja Calif.

Heteroderma minutula Foslie

Dawson, 1959*b*, 1960
Isla Guadalupe; Bahía Tortuga, Baja Calif.; Puerto Guatulco, Oaxaca, to Punta Naranja, Panamá; Clipperton I.

Heteroderma nicholsii Setchell & L. Mason

Dawson, 1960
Bolinas, Calif., to Punta Abreojos, Baja Calif.

Heteroderma parvicarpa Dawson

Dawson, 1960
Scammon Lagoon, Baja Calif.

Heteroderma subtilissima (Foslie) Foslie

Dawson, 1960
Isla Guadalupe, Baja Calif.; southwesternmost Gulf of Calif.

Litholepis accola Foslie

Dawson, 1960
Isla Guadalupe, Baja Calif.; Isla Clarión, Revillagigedo Arch.

Litholepis fertilis (Lemone) Setchell & L. Mason

Setchell & Mason, 1943
Isla Coiba, Panamá

Litholepis sonorensis Dawson

Dawson, 1960
Isla Espíritu Santo, Gulf of Calif.

Choreonema thuretii (Bornet) Schmitz

Taylor, 1945; Hollenberg, 1948; Dawson, 1949, 1960
Southern Calif.; Isla Guadalupe to Bahía Vizcaino, Baja Calif.; southwestern Gulf of Calif.; Revillagigedo; Costa Rica; Galapagos Arch.

Corallina bathybentha Dawson

Dawson, 1949
Southern Calif. Channel Islands

Corallina berterii Mont. ?

Farlow, 1902; Lemoine, 1929 (as *Arthrocardia* sp.)
Galapagos Arch.

Corallina delicatulus (Doty) comb. nov.

Doty, 1947: 167 (as *Joculator delicatulus*)
Cape Arago, Oreg.

Corallina gracilis Lamouroux var. *gracilis*

Dawson, 1945*b*, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Southern Calif. to Isla Cedros, Baja Calif.

Corallina gracilis var. *verticillata* Dawson

Dawson, 1954
Santa Catalina I., Calif. ?; Isla Guadalupe, Baja Calif.

Corallina janioides Dawson

Dawson, 1954
Isla Guadalupe, Baja Calif.

Corallina officinalis Linnaeus var. *officinalis*

Taylor, 1945
Galapagos Arch.

Corallina officinalis var. *chilensis* (Harvey) Kützing

Scagel, 1957; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Northern British Columbia to Isla Magdalena, Baja Calif.; Guayas, Ecuador

Corallina pilulifera Postels & Ruprecht

Scagel, 1957 (as to Alaska records only)
Alaska

Corallina pinnatifolia (Manza) Dawson var. *pinnatifolia*

Dawson, 1954, 1958, 1959*c*; Taylor, 1945 (as *Joculator pinnatifolius*)
Carpinteria, Calif., to Isla Magdalena, Baja Calif.; Galapagos Arch.

Corallina pinnatifolia var. *digitata* Dawson

Dawson, 1954, 1959
Throughout the Gulf of Calif.

Corallina polysticha Dawson

Dawson, 1954, 1959
Santa Catalina I., Calif., to Bahía Vizcaino, Baja Calif.

Corallina vancouveriensis Yendo var. *vancouveriensis*

Dawson, 1954, 1959*c*, 1960*a*; Scagel, 1957; Dawson, Neushul & Wildman, 1960
Southern British Columbia to Punta Lobos, near Todos Santos, Baja Calif.

Corallina vancouveriensis var. *densa* Yendo

Dawson, 1953
Northern part of the range of the species.

Corallina vancouveriensis var. *aculeata* (Yendo) Dawson

Dawson, 1954
Throughout the range of the species.

Corallina vancouveriensis var. *lycopodioides* (Taylor) Dawson

Dawson, 1954
Southern Calif. and Baja Calif.

Serraticardia macmillani (Yendo) Silva 1957

Scagel, 1957; Silva, 1957
Vancouver I., British Columbia; Fort Ross; Pescadero Point, Calif.

Cheilosporum planiusculum (Kützing) Yendo

Yendo, 1902
Port Renfrew, Vancouver I., British Columbia

Cheilosporum frondescens (Postels & Ruprecht) Yendo f. *frondescens*

Yendo, 1902
Port Renfrew, Vancouver I., British Columbia

Cheilosporum frondescens f. *maxima* Yendo

Yendo, 1902
Port Renfrew, Vancouver I., British Columbia

Cheilosporum frondescens f. *intermedia* Yendo

Yendo, 1902
Port Renfrew, Vancouver I., British Columbia

Cheilosporum frondescens f. *polymorpha* Yendo

Yendo, 1902
Port Renfrew, Vancouver I., British Columbia

Pachyarthron cretaceum (Postels & Ruprecht) Manza

Scagel, 1957
Unalaska, Alaska, to northern Wash.

Lithothrix aspergillum J. E. Gray

Dawson, 1954, 1959*c*; Scagel, 1957; Dawson, Neushul & Wildman, 1960
Vancouver I., British Columbia, to Isla Magdalena, Baja Calif.

Bossiella californica (Decaisne) Silva

Scagel, 1957
Southern British Columbia to Monterey, Calif.

Bossiella corymbifera (Manza) Silva

Scagel, 1957
Vancouver I., British Columbia, to Point Lobos, Calif.

Bossiella cooperi (Dawson & Silva) Silva

Silva, 1957
Southern Calif. Channel Islands to Punta Baja, Baja Calif.

Bossiella dichotoma (Manza) Silva var. *dichotoma*

Dawson, 1954, 1959*c*, 1960*a*; Scagel, 1957
Southern British Columbia to Punta Thurloe, Baja Calif.

Bossiella dichotoma var. *gardneri* (Manza) Dawson

Dawson, 1960*a*, 1954 (as *Bossea gardneri*); Silva, 1957 (as *Bossiella gardneri*); Dawson, 1959*c* (as *Bossiella dichotoma-gardneri* complex); Dawson, Neushul & Wildman, 1960 (as *Bossiella gardneri*)
Oreg. to Punta María, Baja Calif.

Bossiella insularis (Dawson & Silva) Silva

Silva, 1957; Dawson, 1958, 1959*c*
Southern Calif. Channel Islands; Port Hueneme, Calif., to Bahía Asunción, Baja, Calif.

Bossiella interrupta (Manza) Silva

Silva, 1957
Pacific Grove, Calif.

Bossiella ligulata (Dawson) Silva

Silva, 1957; Dawson, 1958, 1959*c*
Ventura Co., Calif.; Isla Guadalupe, Baja Calif.

Bossiella orbigniana (Decaisne) Silva

Doty, 1947 (as *Bossea orbigniana*); Dawson, 1954 (as *Bossea orbigniana*); Silva, 1957; Dawson, 1959*c*; Dawson, Neushul & Wildman, 1960
Cape Arago, Oreg. to Isla Cedros, Baja Calif.

Bossiella pachyclada (Taylor) Silva

Dawson, 1954 (as *Bossea pachyclada*); Silva, 1957
Santa Cruz I., Calif., to Isla Cedros, Baja Calif.

Bossiella plumosa (Manza) Silva

Scagel, 1957; Dawson, 1959*c*
Vancouver I., British Columbia, to Government Point, Calif.

Bossiella sagitata (Dawson & Silva) Silva

Silva, 1957; Dawson, 1958, 1959*c*
Southern Calif. Channel Islands; Port Hueneme, Calif.; Islas Coronados; Punta Eugenio, Baja Calif.

Jania adhaerens Lamouroux, prox.

Taylor, 1945
Esmeraldas, Ecuador

Jania arborescens Yendo, prox. ?

Taylor, 1945
Guayas, Ecuador

Jania capillacea Harvey

Taylor, 1945; Dawson, 1954, 1957, 1957*b*, 1959, 1959*b*
Isla Cedros, Baja Calif., to Guayas, Ecuador; Galapagos Arch.

Jania decussato-dichotoma (Yendo) Yendo

Dawson, 1954, 1959
La Jolla, Calif.; southern Gulf of Calif.

Jania longiarthra Dawson

Dawson, 1954, 1957*b*, 1959, 1959*b*
Southern Gulf of Calif.; Golfo de Nicoya, Costa Rica; Clipperton I.

Jania mexicana Taylor

Dawson, 1954
Mazatlán, Sinaloa, to Salina Cruz, Oaxaca

Jania natalensis Harvey

Dawson, 1954, 1958, 1959*c*
Lechuza Point, southern Calif., to Isla Cedros, Baja Calif.

Jania subpinnata Dawson

Dawson, 1954
Bahía de La Paz, Gulf of Calif.

Jania tenella Kützing var. *tenella*

Dawson, 1954, 1954*c*, 1957, 1957*b*, 1959, 1959*b*, 1959*c*
Southern Calif. to Costa Rica; Clipperton I.

Jania tenella var. *zacae* Dawson

Dawson, 1954, 1957*b*
Bahía Vizcaino, Baja Calif.; Isla Ildefonso, Gulf of Calif.; Costa Rica

Jania ungulata Yendo, prox.

Taylor, 1945
Galapagos Arch.; Guayas, Ecuador

Amphiroa annulata Lemoine var. *annulata*

Dawson, 1954, 1957, 1957*b*, 1959
Central Baja Calif.; Southern Gulf of Calif. to Costa Rica; Galapagos Arch.

Amphiroa annulata var. *pinnata* Dawson

Dawson, 1954, 1957*b*
Cape district, Baja Calif.; Golfo Dulce, Costa Rica?

Amphiroa beauvoisii Lamouroux

Dawson, 1957*b*
Costa Rica

Amphiroa brevianceps Dawson

Dawson, 1954; Dawson, Neushul & Wildman, 1960*a*
Punta San Hipólito, Baja Calif.; Guaymas ?, Punta Frailes ?, Gulf of Calif.; Salina Cruz, Oaxaca

Amphiroa compressa Lemoine

Taylor, 1945 (as probably equal to the *A. dilatata* of Farlow, 1902)
Galapagos Arch.

Amphiroa crossiandii Lemoine

Dawson, 1954, 1957
Rocas Alijos, Baja Calif.; Isla Socorro, Revillagigedo Arch. ?; Tangola-Tangola, Oaxaca; Isla Gorgona, Colombia

Amphiroa dimorpha Lemoine var. *dimorpha*

Dawson, 1954, 1954*c*, 1957*b*, 1959; Dawson, Neushul & Wildman, 1960, 1960*a*; Taylor, 1945
Central Pacific Baja Calif. to Central America; Gulf of Calif.; Islas Revillagigedos; Galapagos Arch.

Amphiroa dimorpha var. *digitiforme* Dawson

Dawson, 1959
Isla Carmén; Isla Ildefonso, Gulf of Calif.

Amphiroa drouetii Dawson

Dawson, 1954, 1959
Central and southern Gulf of Calif.

Amphiroa foliacea Lamouroux

Dawson, 1954
Punta Verlero, Bahía Vizcaino, Baja Calif.; Isla María Magdalena, Nayarit

Amphiroa epiphlegnoides J. Agardh, in Harvey

Harvey, 1862
Fuca Strait, Wash.

Amphiroa franciscana Taylor var. *franciscana*

Dawson, 1954
Isla Guadalupe, Baja Calif.; Isla María Magdalena, Nayarit; Esmeraldas; Guayas, Ecuador

Amphiroa franciscana var. *robusta* Dawson

Dawson, 1954
Bahía Agua Verde, Gulf of Calif.; Acapulco, Guerrero

Amphiroa galapagensis Taylor

Taylor, 1945
Galapagos Arch.

Amphiroa magdalenensis Dawson

Dawson, 1954, 1959
Isla Guadalupe; Isla Magdalena, Baja Calif.; southern Gulf of Calif.

Amphiroa mexicana Taylor

Dawson, 1954
Morro de Petatlán, Guerrero; Salina Cruz, Oaxaca

Amphiroa minutissima Taylor

Dawson, 1957*b*
Golfo Dulce, Costa Rica

Amphiroa peruana Areschoug

Taylor, 1945
Galapagos Arch.

Amphiroa subcylindrica Dawson

Dawson, 1954, 1959
Gulf of Calif.; Barra de Navidad, Jalisco

Amphiroa taylorii Dawson

Dawson, 1954, 1954*c*, 1957*b*, 1959
Revillagigedo Arch.; southern Gulf of Calif.; Isla María Magdalena, Nayarit; Costa Rica

Amphiroa tuberculosa (Postels & Ruprecht) Endlicher

Yendo, 1902
Port Renfrew, British Columbia

Amphiroa vanbosseae Lemoine

Taylor, 1945
Galapagos Arch.

Amphiroa zonata Yendo

Taylor, 1945 (as *A. peninsularis*); Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Santa Catalina I., Calif., to Isla Magdalena, Baja Calif.; Gulf of Calif.; Isla María Madre, Nayarit; Esmeraldas, Ecuador

Arthrocardia tuberculosa Weber van Bosse

Lemoine, 1929 (as equal to the *Amphiroa orbigniana* of Farlow, 1902)
Galapagos Arch.

Calliarthron chielosporioides Manza

Smith, 1944; Dawson, 1954; Dawson, Neushul & Wildman, 1960
Bolinas, Calif., to Isla Cedros, Baja Calif.

Calliarthron regenerans Manza

Scagel, 1957; Dawson, Neushul & Wildman, 1960, 1960*a*
Vancouver I., British Columbia, to Isla San Geronimo, Baja Calif.

Calliarthron setchelliae Manza

Smith, 1944
Moss Beach; Monterey, Calif.

Calliarthron schmittii Manza

Dawson, 1949; Scagel, 1957
San Juan I., Wash.; Tanner Bank; San Diego, Calif.

FAM. DERMOCORYNIDACEAE

Dermocorynus occidentalis Hollenberg

Dawson, 1954
Los Angeles Co., Calif., to Punta Banda, Baja Calif.

FAM. CRYPTONEMIACEAE

Grateloupia abreviata Kylin

Hollenberg, 1948; Dawson, 1954, 1959*c*
Southern Calif.

Grateloupia avalonae Dawson

Dawson, 1949
Catalina I., Calif.

Grateloupia dactylifera Dawson

Dawson, 1954
Near Guaymas; Isla Espíritu Santo, Gulf of Calif.

Grateloupia filicina (Lamour.) C. Agardh

Dawson, 1954
Northern Baja Calif. to San Blas, Nayarit; Gulf of Calif.

Grateloupia hancockii Dawson

Dawson, 1954
Kino; vicinity of Guaymas, Gulf of Calif.

Grateloupia howeii Setchell & Gardner

Dawson, 1954, 1959; Dawson, Neushul & Wildman, 1960
Islas San Benito to Isla Magdalena, Baja Calif.; Puerto Libertad, Sonora, to Mazatlán, Sinaloa

Grateloupia (?) *johnstonii* Setchell & Gardner

Dawson, 1954
Isla Ángel de la Guarda, Gulf of Calif.

Grateloupia maxima (Gardner) Kylin

Doty, 1947; Dawson, 1954; Dawson, Neushul & Wildman, 1960*a*
Capa Arago region, Oreg., to Isla Asunción, Baja Calif.

Grateloupia multiphylla Dawson

Dawson, 1954
Islas San Benito to Isla Magdalena, Baja Calif.

Grateloupia pinnata (Postels & Ruprecht) Setchell

Scagel, 1957
Sitka, Alaska, to northern Wash.

Grateloupia prolongata J. Agardh

Dawson, 1954, 1958, 1959, 1959*c*
Gaviota, Calif., to southern Mexico

Grateloupia schizophylla Kützing

Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960; Scagel, 1957 (as *G. californica*)
Southern British Columbia to Isla Magdalena, Baja Calif.

Grateloupia setchellii Kylin

Doty, 1947
Oreg.; Monterey, Calif.

Grateloupia (?) *squarrulosa* Setchell & Gardner

Dawson, 1944
Isla Smith, Gulf of Calif.

Grateloupia versicolor (J. Agardh) J. Agardh var. *versicolor*

Dawson, 1954, 1954*c*, 1959
Isla Magdalena, Baja Calif., to Salina Cruz, Oaxaca; southern Gulf of Calif.

Grateloupia versicolor var. *prostrata* Dawson

Dawson, 1954*c*
Isla San Benedicto, Revillagigedo Arch.

Grateloupia violacea (Setchell & Gardner) Dawson

Dawson, 1961
Northern Gulf of Calif.

Cryptonemia angustata (Setchell & Gardner) Dawson

Dawson, 1954, 1958; Dawson, Neushul & Wildman, 1960; Dawson, 1960*a*
La Jolla, Calif., to southern Baja Calif.; Bahía Tepoca, Sonora; Isla Socorro, Revillagigedo Arch.; Bahía Culebra, Costa Rica

Cryptonemia borealis Kylin

Scagel, 1957
Southern British Columbia to Oreg.

Cryptonemia decolorata Taylor

Dawson, 1954
Isla María Magdalena, Nayarit

Cryptonemia guaymasensis (Dawson) Dawson

Dawson, 1954, 1960*a*
Isla Patos to Bahía San Lucas, Gulf of Calif.; Bahía Culebra, Costa Rica

Cryptonemia obovata J. Agardh

Kylin, 1925; Scagel, 1957; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960, 1960*a*
Prince William Sound, Alaska, to Bahía Tortuga, Baja Calif.

Cryptonemia ovalifolia Kylin

Scagel, 1957
Northern Wash. to Pacific Grove, Calif.

Cryptonemia peltata Dawson, Neushul & Wildman

Dawson, Neushul & Wildman, 1960*a*
Punta Eugenio, Baja Calif.

Cryptonemia veleroae (Dawson) Dawson

Dawson, 1954
Guaymas, Sonora

Aeodes (?) *ecuadoreana* Taylor

Taylor, 1945
Galapagos Arch.

Aeodes gardneri Kylin

Scagel, 1957
Southern British Columbia to San Pedro, Calif.

Carpopeltis bushiae (Farlow) Kylin

Kylin, 1941; Dawson, 1954, 1959*c* (all as *Polyopes bushiae*); Dawson, 1959; Dawson, Neushul & Wildman, 1960; 1960*a*
Southern Calif. to Punta Abreojos, Baja Calif.

Carpopeltis clarionensis (Setchell & Gardner) Dawson

Dawson, 1954 (as *Polyopes clarionensis*); Dawson, 1959
Isla Clarión, Revillagigedo Arch.

Carpopeltis divaricata Okamura

Dawson, Neushul & Wildman, 1960*a*
Punta San Hipólito; Isla Magdalena, Baja Calif.

Carpopeltis stella-polaris Dawson

Dawson, 1959
Isla Ildefonso, Gulf of Calif.

Pachymenia saxicola Taylor

Taylor, 1945
Galapagos Arch.

Halymenia abyssicola Dawson

Dawson, 1954
Isla Partida, Gulf of Calif.

Halymenia actinophysa Howe

Dawson, 1954, 1960*a*
Throughout Gulf of Calif.; Revillagigedo Arch.; Bahía Salinas, Costa Rica

Halymenia agardhii G. DeToni

Dawson, 1954; Dawson, Neushul & Wildman, 1960*a*
Isla Asunción, Baja Calif.; Isla María Magdalena, Nayarit

Halymenia bifida Dawson

Dawson, 1954
Bahía de San Lucas, Baja Calif.

Halymenia californica Smith & Hollenberg

Dawson, 1954; Scagel, 1957
Northern Wash.; Monterey Peninsula, Calif.; Punta María, Baja Calif.

Halymenia megaspora Dawson

Dawson, 1954
Canal de San Lorenzo, Gulf of Calif.

Halymenia santamariae Taylor

Taylor, 1945
Galapagos Arch.

Halymenia utriana Taylor

Taylor, 1945
Bahía Utria, Colombia

Prionitis abbreviata Setchell & Gardner var. *abbreviata*

Taylor, 1945; Dawson, 1954 (as *Zanardinula abbreviata*), 1959
Throughout the Gulf of Calif.; Galapagos Arch.

Prionitis abbreviata var. *guaymasensis* (Dawson) Dawson

Dawson, 1954 (as *Zanardinula abbreviata* var. *guaymasensis*), 1959
Throughout the Gulf of Calif. south to Isla San Pedro Nolasco

Prionitis acroidalea (Setchell & Gardner) comb. nov.

Setchell & Gardner, 1924: 781 (as *Grateloupia acroidalea*); Dawson, 1954 (as *Zanardinula acroidalea*)
Kina, Sonora, to La Paz, Baja Calif.; Galapagos Arch.

Prionitis albemarlensis Taylor

Taylor, 1945
Galapagos Arch.

Prionitis andersoniana Eaton ex J. Agardh

Sanborn & Doty, 1946; Doty, 1947; Dawson, 1945*b*, 1954 (as *Zanardinula andersoniana*), 1959c; Dawson, Neushul & Wildman, 1960
Coos Bay, Oreg., to Punta María, Baja Calif.

Prionitis australis (J. Agardh) J. Agardh

Smith, 1944; Papenfuss, 1944 (as *Zanardinula australis*)
Monterey, Calif.

Prionitis cornea (Okamura) Dawson

Smith, 1944 (as *Prionitis linearis*); Dawson, 1954 (as *Zauardinula cornea*); Papenfuss, 1944 (as *Zanardinula linearis*); Dawson, 1958, 1959*c*; Dawson, Neushul & Wildman, 1960
San Mateo Co., Calif., to Isla San Roque, Baja Calif.

Prionitis delicatula (Taylor) comb. nov.

Taylor, 1945: 210 (as *Prionitis filiformis* f. *delicatula*); Dawson, 1954 (as *Zanardinula delicatula*)
Central Pacific Baja Calif. south to Isla Magdalena

Prionitis filiformis Kylin

Doty, 1947 (as *Zanardinula filiformis*); Dawson, Neushul & Wildman, 1960*a*
Cape Arago, Oreg., to central Calif.; Punta Abreojos, Baja Calif.

Prionitis galapagensis Taylor

Taylor, 1945
Galapagos Arch.

Prionitis hancockii Taylor

Taylor, 1945
Galapagos Arch.

Prionitis lanceolata (Harvey) Harvey

Dawson, 1954 (as *Zanardinula lanceolata*); Scagel, 1957; Dawson, 1959*c*; Dawson, Neushul & Wildman, 1960
Southern British Columbia to Isla Cedros, Baja Calif.

Prionitis lyallii Harvey

Scagel, 1957; Dawson, 1954 (as *Zarnardinula lyallii* var. ?)
Southern British Columbia to Carmel Bay, Calif.; vicinity of Guaymas, Sonora ?

Prionitis mexicana Dawson

Dawson, 1954 (as *Zanardinula mexicana*)
Southern Baja Calif.

Prionitis vizcainensis (Dawson) Dawson, Neushul & Wildman

Dawson, 1954 (as *Zanardinula vizcainensis*); Dawson, Neushul & Wildman, 1960*a*
Bahía Vizcaino, Baja Calif.

Lobocolax deformans Howe

Doty, 1947; Dawson, 1954
Oreg. to central Baja Calif.

FAM. KALLYMENIACEAE

Kallymenia latiloba Taylor

Taylor, 1945
Galapagos Arch.

Kallymenia multiloba Taylor

Taylor, 1945
Galapagos Arch.

Kallymenia oblongifructa Setchell

Scagel, 1957
Sitka; Seldovia, Alaska, to Puget Sound, Wash.

Kallymenia ornata (Postels & Ruprecht) J. Agardh

Scagel, 1957
Yakutat Bay, Alaska, to Vancouver I., British Columbia

Kallymenia pacifica Kylin

Kylin, 1956 (as *Callymenia*); Dawson, Neushul & Wildman, 1960*a*
La Jolla, Calif.; Punta Eugenio, Baja Calif.

Kallymenia (?) *pertusa* Setchell & Gardner

Dawson, 1954 (as *Callymenia*)
Isla San Pedro Mártir, Gulf of Calif.

Kallymenia reniformis (Turner) J. Agardh f. *reniformis*

Scagel, 1957
Southern British Columbia

Kallymenia reniformis f. *cuneata* J. Agardh

Setchell & Gardner, 1903
Unalaska; Morzhovoi Bay, Alaska

Kallymenia setchellii Taylor

Taylor, 1945
Galapagos Arch.

Pugetia fragilissima Kylin

Scagel, 1957
Southern British Columbia to Monterey, Calif.

Callophyllis acrocarpa Setchell

Dawson, 1954*a*
Santa Cruz to Santa Barbara, Calif.

Callophyllis crassifolia Setchell & Swezy

Dawson, 1954*a*
San Mateo Co. to Carmel, Calif.

Callophyllis crenulata Setchell

Scagel, 1957
Northern British Columbia to Pacific Grove, Calif.

Callophyllis dissecta Setchell & Swezy

Dawson, 1954
San Pedro, Calif., to Punta San Quintín, Baja Calif.

Callophyllis edentata Kylin

Scagel, 1957
Hope I., British Columbia, to Oreg.

Callophyllis filicina Setchell & Swezy

Dawson, 1954*a*
Southern Calif.; Islas San Benito, Baja Calif.

Callophyllis firma (Kylin) Norris

Scagel, 1957
Northern British Columbia to Monterey, Calif.

Callophyllis flabellulata Harvey

Scagel, 1957
Northern British Columbia to Coos Bay, Oreg.

Callophyllis gardneri Setchell

Dawson, 1954*a*
Santa Rosa I., Calif., to Bahía Vizcaino, Baja Calif.

Callophyllis heanophylla Setchell

Scagel, 1957
Southern British Columbia to Coos Bay, Oreg.

Callophyllis (?) *ligulata* Taylor

Taylor, 1945
Isla Gorgona, Colombia; Galapagos Arch.

Callophyllis marginifructa Setchell & Swezy

Scagel, 1957; Dawson, 1954; Dawson, Neushul & Wildman, 1960, 1960*a*
Northern Wash. to Sacramento Reef, Baja Calif.

Callophyllis megalocarpa Setchell & Swezy

Dawson, 1954; Scagel, 1957
Northern Wash. to Isla Magdalena, Baja Calif.

Callophyllis obtusifolia J. Agardh

Dawson, 1954, 1959*c*
Santa Cruz, Calif., to Punta Santa Rosalía, Baja Calif.

Callophyllis odonthalioides Setchell

Dawson, 1954*a*
Santa Cruz to San Diego, Calif.

Callophyllis oregona Doty

Doty, 1947
North Bay and Brookings, Oreg.

Callophyllis phyllohaptera Dawson

Dawson, 1954
Punta Descanso to Isla Magdalena, Baja Calif.

Callophyllis pinnata Setchell & Swezy

Dawson, 1954*a*
Oreg. to Punta Baja, Baja Calif.

Callophyllis plumosa Setchell & Swezy

Dawson, 1954*a*, 1959*c*
San Pedro to La Jolla, Calif.

Callophyllis stenophylla Setchell

Dawson, 1949, 1954*a*
Bolinas; Santa Cruz I., Calif.

Callophyllis thompsonii Setchell

Scagel, 1957
Northern Wash.

Callophyllis violacea J. Agardh var. *violacea*

Doty, 1947; Dawson. 1954*a*, 1959*c*; Dawson, Neushul & Wildman, 1960, 1960*a*
Oreg.; Santa Barbara, Calif., to Isla Asunción, Baja Calif.

Callophyllis violacea var. *epiphytica* Dawson

Dawson, 1954, 1957
Central Baja Calif.; Rocas Alijos

Callocolax fungiformis Kylin

Scagel, 1957
Northern Wash.

Callocolax globulosis Dawson

Scagel, 1957
Northern Wash.; San Diego, Calif.

Erythrophyllum delesserioides J. Agardh

Scagel, 1957
Hope I., British Columbia, to San Luis Obispo Co., Calif.

Erythrophyllum gmelini (Grunow) Yendo

Okamura, 1933; Setchell & Gardner, 1903 (as *Callymenia gmelini*)
Atka to Agattu I., Aleutian Islands, Alaska

Erythrophyllum splendens Doty

Doty, 1947
Cape Arago, Oreg.

Euthora cristata (Linnaeus) J. Agardh

Setchell & Gardner, 1903
Shumagin I. to Cook Inlet, Alaska

Euthora fruticulosa (Ruprecht) J. Agardh

Okamura, 1933; Scagel, 1957
Bering Sea to northern Wash.

FAM. CHOREOCOLACEAE

Choreocolax polysiphoniae Reinsch

Dawson, 1954; Scagel, 1957
Sitka, Alaska, to Cabo Colnett, Baja Calif.

ORDER GIGARTINALES

FAM. CRUORIACEAE

Cruoria pacifica Kjellman

Hollenberg, 1948
Southern Calif.

Cruoria profunda Dawson

Dawson, 1961
Cortez Bank, off U.S.–Mexico boundary

Haematocelis rubens J. Agardh

Dawson, 1954, 1961
La Jolla, Calif., to Isla Magdalena, Baja Calif.

Cruoriopsis mexicana Dawson

Dawson, 1954, 1957*b*, 1960*a*, 1961
Islas Coronados, Baja Calif.; San Felipe, Gulf of Calif.; Golfo Dulce, Costa Rica

Petrocelis anastomosans Dawson

Dawson, 1961
Salina Cruz, Oaxaca

Petrocelis ascendens Dawson

Dawson, 1961
Bahía Rosario, Baja Calif.

Petrocelis franciscana Setchell & Gardner

Dawson, 1954, 1959*c*; Scagel, 1957; Dawson, 1961

Northern Wash. to Los Angeles Co., Calif.; Cabo Colnett, Baja Calif.

Petrocelis haematis Hollenberg

Hollenberg, 1943

Southern Calif.

Petrocelis middendorffii (Ruprecht) Kjellman

Scagel, 1957

Bering Sea to Whidbey Is., Wash.

FAM. NEMASTOMACEAE

Schizymenia epiphytica (Setchell & Lawson) Smith & Hollenberg

Smith, 1944; Papenfuss, 1944*a*

Monterey Peninsula, Calif.

Schizymenia pacifica (Kylin) Kylin

Scagel, 1957; Dawson, 1954, 1959*c*, 1961

Unga I., Alaska, to Isla Magdalena, Baja Calif.

Predaea masonii (Setchell & Gardner) J. De Toni

Dawson, 1954; Feldmann, 1942; Dawson, 1961

Isla Guadalupe, Baja Calif.; Isla Clarión, Revillagigedo Arch.; southern Gulf of Calif.

Predaea subpeltata Dawson

Dawson, 1961

Puerto Guatulco, Oaxaca

Platoma fanii Dawson

Dawson, 1961

Isla San Esteban, Gulf of Calif.

FAM. SEBDENIACEAE

Sebdenia rubra Taylor

Taylor, 1945

Galapagos Arch.

FAM. SOLIERIACEAE

Turnerella mertensiana (Postels & Ruprecht) Schmitz

Scagel, 1957

Shumagin I., Alaska, to northern Wash.

Eucheuma uncinatum Setchell & Gardner

Dawson, 1961

Isla Ángel de la Guarda, Gulf of Calif., to Mazatlán, Sinaloa

Agardhiella tenera (J. Agardh) Schmitz

Dawson, 1959*c* (as *A. coulteri*), 1961

Queen Charlotte Str., British Columbia, to Revillagigedo Arch.; Northern Gulf of Calif.; Galapagos Arch.

Gardneriella tuberifera Kylin

Hollenberg, 1948; Dawson, 1961

Monterey Peninsula, Calif., to Punta Baja, Baja Calif.

Opuntiella californica (Farlow) Kylin

Scagel, 1957

Unga I., Alaska, to San Diego, Calif.

Reticulobotrys catalinae Dawson

Dawson, 1961

Santa Catalina I., Calif.; Isla Guadalupe, Baja Calif.

Sarcodiotheca dichotoma (Howe) Dawson

Dawson, 1961

Puerto Refugio to La Paz, Gulf of Calif.

Sarcodiotheca divaricata Taylor

Taylor, 1945

Galapagos Arch.

Sarcodiotheca furcata (Setchell & Gardner) Kylin

Scagel, 1957; Dawson, 1961

Southern British Columbia to Islas Tres Marías Mexico; Puerto Culebra, Costa Rica; Galapagos Arch.

Sarcodiotheca linearis Setchell & Gardner

Dawson, 1961

Isla Magdalena to San Lucas, Baja Calif.

Sarcodiotheca taylorii Dawson

Dawson, 1961

Punta Frailes, Baja Calif.; Islas Tres Marías

Sarcodiotheca tenuis Taylor

Taylor, 1945; Dawson, 1961 (as probably equal to *S. divaricata*)
Galapagos Arch.

FAM. RHABDONIACEAE

Catenella repens (Lightfoot) Batters

Taylor, 1945
Galapagos Arch.; Esmeraldas, Ecuador

Catenella impudica (Montagne) J. Agardh

Taylor, 1945
Bahía Buenaventura, Colombia

FAM. RHODOPHYLLIDACEAE

Rhodophyllis dichotoma f. *setacea* Kjellman

Setchell & Gardner, 1903
Unalaska, Alaska

FAM. HYPNEACEAE

Hypneocolax stellaris f. *orientalis* Weber van Bosse

Dawson, 1961
Bahía Magdalena, Baja Calif.

Hypnea boergesenii Tanaka

Dawson, 1960*a*
Isla Brincanco, Panamá

Hypnea cervicornis J. Agardh

Taylor, 1945; Dawson, 1957, 1959, 1961
Isla Guadalupe, Scammon Lagoon, Bahía Santa María, Baja Calif.; San Felipe to Bahía San Lucas, Gulf of Calif.; Guayas, Ecuador; Galapagos Arch.

Hypnea johnstonii Setchell & Gardner

Dawson, 1958, 1961
Newport Harbor, Calif.; southern Baja Calif.; Gulf of Calif.; Isla San Benedicto; Revillagigedo Arch.; to San Blas, Nayarit

Hypnea marchantae Setchell & Gardner

Taylor, 1945
Isla Gorgona, Colombia; La Libertad, Ecuador

Hypnea pannosa J. Agardh

Dawson, 1954*c*, 1957*b*, 1961
Isla Pond, Gulf of Calif., to Islas Secas, Panamá; Galapagos Arch.

Hypnea spicifera (Suhr) Harvey ?

Dawson, 1961
Mazatlán, Sinaloa

Hypnea spinella (C. Agardh) Kützing

Dawson, 1959*b*, 1961
Guaymas, Sonora, to Bahía Petatlán, Guerrero; Clipperton I.

Hypnea valentiae (Turner) Montagne

Dawson, 1961
Santa Barbara, Calif., to Guayas, Ecuador

Hypnea variabilis Okamura

Dawson, 1961
Catalina I.; La Jolla, Calif., to Isla San Roque, Baja Calif.

FAM. PLOCAMIACEAE

Plocamium coccineum (Hudson) Lyngbye var. *coccineum*

Farlow, 1902
Galapagos Arch.

Plocamium coccineum var. *pacificum* (Kylin) Dawson

Dawson, 1957, 1959*c*; Scagel, 1957; Dawson, Neushul & Wildman, 1960, 1960*a* (all as *P. pacificum*); Dawson, 1961
Southern British Columbia to Rocas Alijos and Revillagigedo Arch.

Plocamium oreganum Doty

Scagel, 1957
Southern British Columbia to Sonoma Co., Calif.

Plocamium tenue Kylin

Scagel, 1957; Doty, 1947
Sitka, Alaska, to South Bay, Oreg.

Plocamium violaceum Farlow

Scagel, 1957; Dawson. 1959*c*, 1961
Southern British Columbia to Islas San Benito, Baja Calif.

Plocamiocolax pulvinata Setchell

Scagel, 1957; Dawson, 1961
Northern Wash. to Cabo Colnett, Baja Calif.; Isla Guadalupe

FAM. SPHAEROCOCCACEAE

Caulacanthus indicus Weber van Bosse

Dawson, 1957*b*
Golfo Dulce, Costa Rica ?

Caulacanthus ustulatus Kützing

Dawson, 1961
Isla Cedros to Isla Margarita, Baja Calif.; Isla Turner, Gulf of Calif.

Taylorophycus laxa (Taylor) Dawson

Dawson, 1961
Isla Magdalena, Baja Calif.

FAM. GRACILARIACEAE

Gelidiopsis tenuis Setchell & Gardner

Dawson, 1954, 1957*b*, 1959, 1961
Guaymas, Sonora, to Costa Rica; Revillagigedo Arch.

Gelidiopsis variabilis (Greville) Schmitz

Dawson, 1954, 1959, 1960*a*, 1961
Guaymas, Sonora, to Bahía Santiago, Colima

Gracilaria ascidiicola Dawson

Dawson, 1961
Puerto Escondido, Gulf of Calif.

Gracilaria brevis Taylor

Taylor, 1945
Guayas, Ecuador

Gracilaria cerrosiana Taylor

Dawson, 1961
Isla Cedros to Punta Abreojos, Baja Calif.

Gracilaria crispata Setchell & Gardner

Dawson, 1957*b*, 1961
Isla Tiburón, Sonora, to Costa Rica; Revillagigedo Arch.

Gracilaria ecuadoreanas (Taylor) Dawson

Dawson, 1949*b*
Galapagos Arch.

Gracilaria (?) *linearis* Kylin

Smith, 1944; Dawson, 1949*b* (as not of the genus *Gracilaria*)
Monterey Península; Point Sur, Calif.

Gracilaria marcialana Dawson

Dawson, 1961
Bahía Agua Verde; Isla Espíritu Santo, Gulf of Calif.

Gracilaria pachydermatica Setchell & Gardner

Dawson, 1961
Isla Cedros to Isla Magdalena, Baja Calif.; throughout the Gulf of Calif.

Gracilaria ramisecunda Dawson

Dawson, 1961
Southern Gulf of Calif.

Gracilaria rubrimembra Dawson

Dawson, 1961
Vicinity of Guaymas, Sonora

Gracilaria rugulosa Montagne ?

Farlow, 1902
Galapagos Arch.

Gracilaria skottsbergii Taylor

Dawson, 1949*b*
Galapagos Arch.

Gracilaria spinigera Dawson

Dawson, 1961
Guaymas to Puerto Escondido, Gulf of Calif.; Isla Margarita, Baja Calif.

Gracilaria subsecundata Setchell & Gardner

Dawson, 1961
Throughout the Gulf of Calif. to Bahía Topolobampo, Sinaloa

Gracilaria symmetrica Dawson

Dawson, 1961
Bahía Chamela, Jalisco; Bahía Chacahua, Oaxaca; Bahía Santa Elena, Costa Rica

Gracilaria tepocensis (Dawson) Dawson

Dawson, 1961
Northern Gulf of Calif.; Costa Rica

Gracilaria textorii (Suringar) J. Agardh var. *textorii*

Dawson, 1961
Vicinity of Punta Eugenio; Punta Pequeña, Baja Calif.; Gulf of Calif.; Galapagos Arch.

Gracilaria textorii var. *cunninghamii* (Farlow) Dawson

Dawson, 1961; Dawson, Neushul, & Wildman, 1960 (as *G. cunninghamii*)
Santa Barbara, Calif., to Isla Magdalena, Baja Calif.

Gracilaria turgida Dawson

Dawson, 1961
Newport Harbor, Calif.; Bahía Magdalena, Baja Calif.

Gracilaria veleroae Dawson

Dawson, 1961
San Diego Co., Calif; northern Gulf of Calif. to Acapulco, Guerrero; Revillagigedo Arch.

Gracilaria verrucosa (Hudson) Papenfuss

Taylor, 1945 (as *G. confervoides* in part); Scagel, 1957; Dawson, 1961
Southern British Columbia to central Gulf of Calif.; Guayas, Ecuador ?

Gracilariopsis andersonii (Grunow) Dawson

Dawson, 1961; Kylin, 1941 (as *Gracilaria andersonii*)
Santa Barbara Co., Calif., to Punta María, Baja Calif.

Gracilariopsis claviformis Dawson

Dawson, 1961*a*
Near Santa Cruz I., Calif.

Gracilariopsis costaricensis Dawson

Dawson, 1957*b*, 1961
Bahía Tenacatita, Jalisco; Costa Rica

Gracilariopsis megaspora Dawson

Dawson, 1961
Bahía San Carlos, Sonora

Gracilariopsis panamensis (Taylor) Dawson

Dawson, 1949*b*
Puerto Culebra, Costa Rica; Isla Taboga, Panama; Galapagos Arch.

Gracilariopsis rhodotricha Dawson

Dawson, 1961
Revillagigedo Arch.

Gracilariopsis robusta (Setchell) Dawson

Dawson, 1949*b*
Monterey Peninsula, Calif.

Gracilariopsis sjoestedtii (Kylin) Dawson

Scagel, 1957; Dawson & Beaudette, 1960; Dawson, 1961
Vancouver I., British Columbia, to Bahía Salinas, Costa Rica

Gracilariophila gardneri Setchell

Dawson, 1945*c*, 1961
Santa Monica to La Jolla, Calif.; Bahía Bocochibampo, Sonora

Gracilariophila oryzoides Setchell & Wilson

Doty, 1947; Dawson, 1961
Coos Bay, Oreg., to Bahía Rosario, Baja Calif.

FAM. DICRANEMACEAE

Dicranema rosaliae Setchell & Gardner

Dawson, 1961
Throughout the Gulf of Calif. to Puerto Parker, Costa Rica

FAM. PHYLLOPHORACEAE

Phyllophora californica (J. Agardh) Kylin

Dawson, 1959*c*, 1961
San Francisco; Santa Barbara, Calif., to Punta San Hipólito, Baja Calif.

Phyllophora clevelandii Farlow

Dawson, 1961
Bolinas, Calif., to Socorro, Baja Calif.

Phyllophora submaritimus Dawson

Dawson, 1961
Cortes Bank, Calif.; Bahía Tortuga, Baja Calif.

Petroglossum pacificum Hollenberg

Hollenberg, 1943, 1945; Doty, 1947; Kylin, 1956 (as *Phyllophora pacificum*)
Coos Bay, Oreg., to La Jolla, Calif.

Petroglossum parvum Hollenberg

Dawson, 1959*c*, 1961
Laguna Beach, Calif., to Isla Cedros, Baja Calif.

Ahnfeltia concinna J. Agardh

Dawson 1954*c*, 1961; Scagel, 1957
Southern British Columbia to Oaxaca, Mexico; Isla San Benedicto, Revillagigedo Arch.

Ahnfeltia durvillaei (Bory) J. Agardh var. *durvillaei*

Taylor, 1945
Galapagos Arch.

Ahnfeltia durvillaei var. *implicata* (Kützing) Howe

Taylor, 1945
Galapagos Arch.

Ahnfeltia plicata (Hudson) Fries

Okamura, 1933; Scagel, 1957; Dawson, 1959*c*, 1961
Bering Sea to Punta Baja, Baja Calif.

Ahnfeltia svensonii Taylor

Dawson, 1961
Southern Gulf of Calif.; Galapagos Arch.

Gymnogongrus ? carnosus Setchell & Gardner

Dawson, 1961
Isla San Pedro Mártir, Gulf of Calif.

Gymnogongrus crustiforme Dawson

Dawson, 1961
Salina Cruz, Oaxaca

Gymnogongrus griffithsiae var. *galapagensis* Piccone & Grunow

Taylor, 1945
Galapagos Arch.

Gymnogongrus guadalupensis Dawson

Dawson, 1961
Isla Guadalupe; near Cabo San Lucas, Baja Calif.

Gymnogongrus johnstonii (Setchell & Gardner) Dawson

Dawson, 1961
Gulf of Calif. to Salina Cruz, Oaxaca; Bahía Salinas, Costa Rica; Revillagigedo Arch.

Gymnogongrus leptophyllus J. Agardh

Doty, 1947; Dawson, 1959*c*, 1961; Dawson, Neushul & Wildman, 1960
Oreg. to Punta Baja, Baja Calif.

Gymnogongrus linearis (Turner) J. Agardh

Doty, 1947
Cape Perpetua, Oreg., to San Luis Obispo Co., Calif.

Gymnogongrus martinensis Setchell & Gardner

Dawson, 1961
Isla San Martin to Isla Magdalena, Baja Calif.

Gymnogongrus melanothrix Grunow

Taylor, 1945
Galapagos Arch.

Gymnogongrus norvegicus (Gunner) J. Agardh

Scagel, 1957
Southern British Columbia to northern Wash.

Gymnogongrus platyphyllus Gardner

Scagel, 1957; Dawson, 1959*c*, 1961
Southern British Columbia to Punta Santa Rosalía, Baja Calif.

Gymnogongrus serenei Dawson

Dawson, 1961
Cabo San Lucas, Baja Calif.; Isla San Benedicto, Revillagigedo Arch.

Gymnogongrus smithii Taylor

Taylor, 1945
Galapagos Arch.

Gymnogongrus vermicularis J. Agardh

Taylor, 1945
Galapagos Arch.

Stenogramme interrupta (C. Agardh) Montagne

Dawson, 1959*c*, 1961; Scagel, 1957 (as *S. californica*); Kylin, 1956 (as *S. californica*); Dawson, Neushul & Wildman, 1960
Southern British Columbia to Cabo San Lucas, Baja Calif.; Revillagigedo Arch,; Galapagos Arch.

FAM. GIGARTINACEAE

Chondrus (?) *albemarlensis* Taylor

Taylor, 1945
Galapagos Arch.

Chondrus canaliculatus Greville

Farlow, 1902
Galapagos Arch.

Chondrus crispus (Linnaeus) Lyngbye

Setchell & Gardner, 1903
Bering Sea to Unalaska, Alaska

Chondrus (?) *hancockii* Taylor

Taylor, 1945
Galapagos Arch.

Gigartina agardhii Setchell & Gardner

Smith, 1944
Fort Ross to La Jolla ?, Calif.

Gigartina armata J. Agardh var. *armata*

Dawson, 1951*a*, 1961
Southern Calif. to Isla San Martín, Baja Calif. ?

Gigartina armata var. *echinata* (Gardner) Dawson

Dawson, 1961
Santa Catalina I.; La Jolla, Calif.; Isla Guadalupe, Baja Calif.

Gigartina asperifolia J. Agardh

Setchell & Gardner, 1933; Dawson, 1958, 1959*c*, 1961
Santa Barbara, Calif., to Punta Santa Rosalia, Baja Calif.

Gigartina californica J. Agardh

Smith, 1944; Sanborn & Doty, 1946; Doty, 1947; Dawson, 1959*c*, 1961
Coos Bay, Oreg., to near Punta María, Baja Calif.

Gigartina canaliculata Harvey

Doty, 1947; Dawson, 1959*c*, 1961; Dawson, Neushul & Wildman, 1960
Coos Bay, Oreg., to Isla Magdalena, Baja Calif.

Gigartina chauvinii (Bory) Montagne

Taylor, 1945
Galapagos Arch.

Gigartina corymbifera (Kützing) J. Agardh

Scagel, 1957 (in part as *G. binghamii*); Dawson, 1961
Northern Wash. to San Quintin, Baja Calif.

Gigartina dichotoma Gardner

Setchell & Gardner, 1933
Duxbury Reef to Point Sur, Calif.

Gigartina exasperata Harvey & Bailey

Scagel, 1957
Southern British Columbia to northern Calif.

Gigartina harveyana (Kützing) Setchell & Gardner

Doty, 1947; Dawson, 1959*c*, 1961
Oreg. to near Punta María, Baja Calif.

Gigartina intermedia Suringar

Dawson, 1961
Isla Tortuga, Gulf of Calif.; Mazatlan, Sinaloa

Gigartina jardinii J. Agardh

Setchell & Gardner, 1933
Monterey; Santa Barbara, Calif.

Gigartina johnstonii Dawson

Dawson, 1961
Northern Gulf of Calif. south to Guaymas

Gigartina latissima (Harvey) Eaton

Scagel, 1957
Table I., British Columbia, to northern Wash.

Gigartina leptorhynchos J. Agardh f. *leptorhynchos*

Dawson, 1959*c*, 1961
Santa Cruz, Calif., to Isla Cedros, Baja Calif.

Gigartina leptorhynchos f. *latissima* Dawson

Dawson, 1949, 1961
Point Arguello, Calif.; Isla San Martín, Baja Calif.

Gigartina leptorhynchos f. *cylindrica* Dawson

Dawson, 1949, 1954, 1961
Southern Calif. and northern Baja Calif.

Gigartina lessonii J. Agardh

Farlow, 1902
Galapagos Arch.

Gigartina macdougalii Dawson

Dawson, 1961
Northern Gulf of Calif. south to Isla Tiburón

Gigartina mamillosa (Goodenough & Woodward) J. Agardh

Scagel, 1957
Southern British Columbia to Seal Rocks, Oreg.

Gigartina multidichotoma Dawson

Dawson, 1961
Santa Catalina I.; La Jolla, Calif.; Punta Descanso, Baja Calif.

Gigartina papillata (C. Agardh) J. Agardh f. *papillata*

Scagel, 1957 (in part as *G. cristata*); Dawson, 1959*c*, 1961; Hollenberg, 1948
Northern Wash. to Punta Baja, Baja Calif.

Gigartina papillata f. *cristata* Setchell

Scagel, 1957; Dawson, 1959*c* (both as *G. cristata*), Dawson, 1961
Northern Wash. to Bahía Rosario, Baja Calif.

Gigartina pectinata Dawson

Dawson, 1961
Northern Gulf of Calif.

Gigartina serrata Gardner

Setchell & Gardner, 1933; Dawson, 1959*c*, 1961
Balboa, Calif., to Isla Magdalena, Baja Calif.

Gigartina sitchensis Ruprecht

Scagel, 1957
Sitka, Alaska, to Whidbey I., Wash.

Gigartina spinosa (Kützing) Harvey

Coe, 1932; Smith, 1944; Dawson, 1959*c*, 1961
Monterey, Calif., to Punta Baja, Baja Calif.

Gigartina stellata (Stackhouse) Batters

Scagel, 1957
West Coast of Vancouver I., British Columbia

Gigartina tepida Hollenberg

Dawson, 1959, 1961
Balboa Harbor, Calif.; Bahía San Quintin, Baja Calif.; northern Gulf of Calif. south to Topolobampo, Sinaloa

Gigartina turneri Setchell & Gardner

Setchell & Gardner, 1933; Dawson, 1945*b*
Southern Calif.

Gigartina unalaschensis (Ruprecht) Ruprecht

Scagel, 1957
Bering Sea to northern Wash.

Gigartina volans (C. Agardh) J. Agardh

Doty, 1947; Dawson, 1959*c*, 1961; Dawson, Neushul & Wildman, 1960
Coos Bay, Oreg., to near Punta María, Baja Calif.

Rhodoglossum affine (Harvey) Kylin

Scagel, 1957; Dawson, 1959*c*, 1961
Southern British Columbia to Isla San Roque, Baja Calif.

Rhodoglossom americanum Kylin

Smith, 1944; Dawson, 1945*b*, 1958, 1959*c*, 1961
Bolinas, Calif., to near Punta María, Baja Calif.

Rhodoglossum cobinae Dawson

Dawson, 1961
Punta María to Isla Magdalena, Baja Calif.

Rhodoglossum coriaceum Dawson

Dawson, 1958, 1959*c*, 1961
Santa Cruz I.; Ventura, Calif., to near Punta María, Baja Calif.

Rhodoglossum diffusum Dawson

Dawson, 1961
Isla Ángel de la Guarda, Gulf of Calif.

Rhodoglossum digitatum Dawson

Dawson, 1961
Isla Partida; Isla Rasa, Gulf of Calif.

Rhodoglossum hancockii Dawson

Dawson, 1961
Northern Gulf of Calif.

Rhodoglossum latissimum J. Agardh

Scagel, 1957
Northern British Columbia to northern Wash.

Rhodoglossum linguiforme Dawson

Dawson, 1961
Arroyo Hondo, southern Calif., to Punta Cono (?), Baja Calif.

Rhodoglossum parvum Smith & Hollenberg

Smith, 1944; Hollenberg, 1948
Monterey; southern Calif.

Rhodoglossum roseum (Kylin) G. M. Smith

Smith, 1944; Dawson, 1959*c*, 1961
Monterey Peninsula, Calif.; Punta Descanso to Punta Baja, Baja Calif.

Iridaea agardhiana (Setchell & Gardner) Kylin

Smith, 1944; Sanborn & Doty, 1946; Doty, 1947 (all as *Iridophycus flaccidum*); Kylin, 1941; Dawson, 1959*c* (as *Iridaea flaccidum*)
Cape Arago, Oreg., to Government Point, Calif.

Iridaea californica J. Agardh

Kylin, 1941
Santa Barbara, Calif.

Iridaea cordata (Turner) Bory

Scagel, 1957
Banks I., British Columbia to Oreg.

Iridaea coriaceum (Setchell & Gardner) Scagel

Scagel, 1957
Northern Wash. to Carmel, Calif.

Iridaea fulgens (Setchell & Gardner) Papenfuss

Setchell & Gardner, 1937; Doty, 1947 (both as *Iridophycus fulgens*); Papenfuss, 1958
Cape Arago, Oreg.; Trinidad, Humbolt Co., Calif.

Iridaea furcata (Setchell & Gardner) Papenfuss

Papenfuss, 1958
Sitka, Alaska

Iridaea heterocarpa Postels & Ruprecht

Scagel, 1957; Dawson, 1959*c*
Northern British Columbia to Government Point, Calif.

Iridaea lineare (Setchell & Gardner) Kylin

Smith, 1944; Doty, 1947 (both as *Iridophycus lineare*); Kylin, 1941; Dawson, 1959*c*
Cape Mears, Oreg., to Ventura, Calif.

Iridaea oregana (Doty) Papenfuss

Papenfuss, 1958
Brookings, Oreg.

Iridaea parksii (Setchell & Gardner) Papenfuss

Papenfuss, 1958
Trinidad, Calif.

Iridaea parvula (Kjellman) Papenfuss

Okamura, 1933 (as *Iridaea laminarioides* var. *parvula*); Papenfuss, 1958
Aleutian Islands to Kodiak I., Alaska

Iridaea reediae (Setchell & Gardner) Papenfuss

Dawson, 1958, 1959*c*; Papenfuss, 1958
Bushnell's Beach, San Luis Obispo Co., and Solromar, Ventura Co., Calif.

Iridophycus sanguineum Setchell & Gardner

Kylin, 1941; Dawson, 1945*c* (both as probably identical with *Iridaea californica*); Doty, 1947
Cape Arago, Oreg., to Pacific Grove, Calif.

Iridaea sinicola (Setchell & Gardner) Papenfuss

Papenfuss, 1958
San Francisco Bay, Calif.

Iridaea splendens (Setchell & Gardner) Papenfuss

Doty, 1947 (as *Iridophycus splendens*); Papenfuss, 1958; Dawson, 1958, 1959*c*
Cape Kiawandi, Oreg.; Monterey Peninsula and Government Point, Calif.

Iridaea whidbeyanum (Setchell & Gardner) Scagel

Scagel, 1957
Southern British Columbia to Oreg.

Besa papillaeformis Setchell

Smith, 1944
Lands End, San Francisco; Monterey, Calif.

ORDER RHODYMENIALES

FAM. RHODYMENIACEAE

Fauchea (?) *crispa* Taylor

Dawson, 1954
Isla María Magdalena, Nayarit

Fauchea fryeana Setchell

Scagel, 1957
Southern British Columbia to northern Wash.

Fauchea galapagensis Taylor f. *galapagensis*

Taylor, 1945
Galapagos Arch.

Fauchea galapagensis f. *pygmaea Taylor*

Taylor, 1945
Galapagos Arch.

Fauchea laciniata J. Agardh var. *laciniata*

Dawson, 1954; Scagel, 1957; Sparling, 1957; Dawson, Neushul & Wildman 1960, 1960a; Hollenberg, 1948 (as *F. media*)
Southern British Columbia to Isla Asunción, Baja Calif.

Fauchea laciniata f. *pygmaea* Setchell & Gardner

Kylin, 1941; Dawson, 1949*a* (both as *F. pygmaea*); Dawson, 1954; Dawson, Neushul & Wildman, 1960*a*; Sparling, 1957 (as *F. laciniata*)
Throughout the southern part of the range of the species

Fauchea mollis Howe

Dawson, 1954
La Paz, Baja Calif.

Fauchea rhizophylla Taylor

Taylor, 1945
Galapagos Arch.

Fauchea sefferi Howe

Dawson, 1954
La Paz, Baja Calif.

Faucheocolax attenuata Setchell

Scagel, 1957; Sparling, 1957
Northern Wash. to Monterey Peninsula, Calif.

Gloioderma conjuncta (Setchell & Gardner) Dawson

Dawson, 1954 (as *Estebania conjuncta*); Dawson, 1959
Northern Gulf of Calif. south to Isla Tortuga

Sciadophycus stellatus Dawson

Dawson, 1954; Dawson, Neushul & Wildman, 1960
Southern Calif. to southern Baja Calif.

Leptofauchea pacifica Dawson

Dawson, 1954
Isla Cedros, Baja Calif.

Fryella gardneri (Setchell) Kylin

Scagel, 1957
Southern British Columbia to Oreg.

Botryocladia beaudettei Dawson

Dawson, 1960*a*
Bahía Potrero Grande, Costa Rica

Botryocladia chiajeana (Meneghini) Kylin ?

Dawson, 1957 Dawson, Neushul & Wildman, 1960*a*
Near Punta Eugenio; Rocas Alijos, Baja Calif.

Botryocladia hancockii Dawson

Dawson, 1954
Bahía Agua Verde, Gulf of Calif.

Botryocladia neushulii Dawson

Dawson 1958; Dawson, Neushul & Wildman, 1960
Goleta, Calif., to Bahía San Quintín, Baja Calif.

Botryocladia pseudodichotoma (Farlow) Kylin var. *pseudodichotoma*

Scagel, 1957; Dawson, 1954; Dawson, Neushul & Wildman, 1960, 1960*a*
Vancouver I., British Columbia, to Isla María Magdalena, Nayarit; Isla Socorro, Revillagigedo Arch.; Galapagos Arch.

Botryocladia pseudodichotoma var. *datilensis* Dawson

Dawson, 1954
Isla Tiburón; near Guaymas, Gulf of Calif.

Botryocladia tenuissima Taylor

Taylor, 1945
Galapagos Arch.

Botryocladia uvarioides Dawson

Dawson, 1954, 1959
Southern Gulf of Calif.

Halosaccion glandiforme (Gmelin) Ruprecht

Scagel, 1957
Westernmost Aleutian Islands, Alaska, to Monterey Peninsula, Calif.

Halosaccion ramentaceum (Linnaeus) J. Agardh

Setchell & Gardner, 1903
Sannak I. to Cook Inlet, Alaska

Halosaccion tilesii Kjellman

Setchell & Gardner, 1903
Kukak Bay to Wrangel, Alaska

Drouetia coalescens (Farlow) G. De Toni

G. De Toni, 1938; Taylor, 1945 (as *Herpophyllon coalescens*); Dawson, 1949
Galapagos Arch.

Drouetia rotata Dawson

Dawson, 1949; Dawson, Neushul & Wildman, 1960 (partly as *D. peltata* by error), 1960*a*
Southern Calif. Channel Islands to Baja Calif.

Rhodymenia arborescens Dawson

Dawson, 1954; Dawson, Neushul & Wildman, 1960, 1960*a*
Southern Calif. to Isla Magdalena, Baja Calif.

Rhodymenia attenuata Dawson

Smith, 1944; Dawson, Neushul & Wildman, 1960, 1960*a*
Monterey, Calif., to Isla Asunción, Baja Calif.

Rhodymenia californica Kylin

Taylor, 1945; Dawson, 1954, 1949*a*, 1951*a*, 1959, 1959*c*; Scagel, 1957; Sparling, 1957; Dawson, Neushul & Wildman, 1960
Southern British Columbia to Isla Magdalena, Baja Calif.; Isla Carmén, Gulf of Calif.; Galapagos Arch.

Rhodymenia dawsonii Taylor

Dawson, 1954; Dawson, Neushul & Wildman, 1960*a*
Bahía Tortuga, Isla Magdalena, Baja Calif.

Rhodymenia decumbens Taylor

Taylor, 1945
Galapagos Arch.

Rhodymenia divaricata Dawson

Taylor, 1945; Dawson, 1954
Northern Gulf of Calif.; Galapagos Arch.

Rhodymenia flabellifolia Bory

Taylor, 1945; Dawson, 1941
Galapagos Arch.

Rhodymenia hancockii Dawson

Dawson, 1954, 1959
Isla Ángel de la Guarda; Bahía Agua Verde, Gulf of Calif.

Rhodymenia lobata Dawson

Smith, 1954; Dawson, 1954
Monterey, Calif.; near Isla Isabel, Nayarit

Rhodymenia lobulifera Dawson

Smith, 1944; Dawson, 1959*c*
Bolinas to San Pedro, Calif.

Rhodymenia pacifica Kylin

Scagel, 1957; Sparling, 1957; Dawson, 1959*c*; Dawson, Neushul & Wildman, 1960, 1960*a*
Northern British Columbia to Punta Cabras, Baja Calif.

Rhodymenia palmata (Linnaeus) Greville f. *palmata*

Okamura, 1933; Scagel, 1957
Aleutian Islands, Alaska, to northern Wash.

Rhodymenia palmata f. *mollis* Setchell & Gardner

Scagel, 1957
Agattu I., Alaska, to Pacific Grove, Calif.

Rhodymenia palmata f. *sarniensis* (Mertens) J. Agardh

Setchell & Gardner, 1903
Kodiak Is. to Orca, Alaska

Rhodymenia palmetta (Esper) Greville

Taylor, 1945
Galapagos Arch.

Rhodymenia palmettiformis Dawson

Dawson, 1945, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
La Jolla, Calif., to Punta Baja, Baja Calif.

Rhodymenia pertusa (Postels & Ruprecht) J. Agardh

Scagel, 1957; Sparling, 1957
Alaska to Coos Bay, Oreg.

Rhodymenia rhizoides Dawson

Dawson, 1941, 1945, 1959*c*
Lechuza Point to San Diego, Calif.

Rhodymenia rosea Dawson

Dawson, 1954
Isla Ángel de la Guarda, Gulf of Calif.

Rhodymenia stipitata Kylin

Scagel, 1957
British Columbia; Puget Sound, Wash.

Rhodymeniocolax botryoidea Setchell

Scagel, 1957; Sparling, 1957
Northern Wash. to San Diego, Calif.

FAM. LOMENTARIACEAE

Binghamia californica J. Agardh

Silva, 1952
Santa Barbara to Santa Monica, Calif.

Binghamia forkii (Dawson) Silva

Dawson, 1945; Hollenberg, 1948 (both as *Binghamiella*); Dawson, 1954, 1957 (as *Binghamiella* by error); Dawson, Neushul & Wildman, 1960, 1960*a*
Laguna Beach, Calif., to Isla Asunción; Rocas Alijos, Baja Calif.

Lomentaria baileyana (Harvey) Farlow

Dawson, 1954
Bahía Vizcaino, Baja Calif.; Revillagigedo Arch.; Puerto Culebra, Costa Rica

Lomentaria caseae Dawson

Dawson, 1946
Del Mar, Calif.

Lomentaria catenata Harvey

Dawson, 1954
Punta Santa Rosalía; Isla Magdalena, Baja Calif.; northern Gulf of Calif.

Lomentaria hakodatensis Yendo

Dawson, 1954, 1960*a*; Dawson, Neushul & Wildman, 1960*a*
Isla Guadalupe; Islas San Benito; Laguna de San Ignacio, Baja Calif.; northern Gulf of Calif. to Puerto Culebra, Costa Rica

Champia parvula (C. Agardh) Harvey

Taylor, 1945; Dawson, 1954, 1954*c*, 1957*b*; 1959
Revillagigedo Arch.; Gulf of Calif. to Golfo de Nicoya, Costa Rica; Esmeraldas, Ecuador

Gastroclonium coulteri (Harvey) Kylin

Scagel, 1957; Dawson, 1954, 1958*c*; Dawson, Neushul & Wildman, 1960
Nootka Sound, British Columbia, to Bahía Asunción, Baja Calif.

Coeloseira compressa Hollenberg

Dawson, 1954; Dawson, Neushul & Wildman, 1960*a*
Pacific Grove, Calif., to Isla Asunción, Baja Calif.

Coeloseira pacifica Dawson

Dawson, 1954
Northern Gulf of Calif. south to Guaymas

Coeloseira parva Hollenberg

Dawson, 1954
Redondo, Calif., to Punta Santa Rosalía, Baja Calif.

ORDER CERAMIALES

FAM. CERAMIACEAE

Crouania attenuata (Bonnemaison) J. Agardh

Dawson, 1954, 1957
Isla Guadalupe; Bahía Vizcaino; Rocas Alijos, Baja Calif.

Lejolisia colombiana Taylor

Taylor, 1945
Isla Gorgona, Colombia

Gymnothamnium elegans (Schousboe) J. Agardh

Hollenberg, 1948; Dawson, 1954; Taylor, 1945
Southern Calif.; Isla Clarión, Revillagigedo Arch.; Galapagos Arch.

Antithamnion alternans Gardner

Gardner, 1927*b*
Cook Inlet, Alaska

Antithamnion asymmetricum Gardner

Gardner, 1927*c*
Sitka, Alaska

Antithamniun baylesiae Gardner

Doty, 1947
South Slough, near Charleston, Oreg.; Monterey Peninsula, Calif.

Antithamnion breviramosus Dawson

Dawson, 1954, 1957, 1957*b*, 1959, 1960*a*
Santa Catalina I., Calif., to Isla del Rey, Panama; southern Gulf of Calif.

Antithamnion defectum Kylin

Scagel, 1957
Northern British Columbia to Monterey, Calif.

Antithamnion dendroideum Smith & Hollenberg

Smith, 1944
Monterey, Calif.

Antithamnion densiusculum Gardner

Scagel, 1957
Southern British Columbia to Pacific Grove, Calif.

Antithamnion dumontii Dawson

Dawson, 1960*a*
Isla del Caño, Costa Rica, to Isla Jicarón, Panama

Antithamnion floccosum (Müller) Kleen

Scagel, 1957
Southern British Columbia to northern Wash.

Antithamnion gardneri G. De Toni

G. De Toni, 1935; Doty, 1947 (as *A. tenuissimum*)
Coos Bay, Oreg.; La Jolla, Calif.

Antithamnion glanduliferum Kylin

Scagel, 1957; Dawson, 1954*d*; Dawson, Neushul & Wildman, 1960*a*
Southern British Columbia to Isla Asunción, Baja Calif.

Antithamnion kylinii Gardner

Scagel, 1957; Dawson, 1954
Victoria, British Columbia, to Punta San Hipólito, Baja Calif.

Antithamnion mcnabbii Dawson

Dawson, 1959
Bahía Agua Verde, Gulf of Calif.

Antithamnion nigricans Gardner

Scagel, 1957
Vancouver I., British Columbia

Antithamnion occidentale Kylin

Taylor, 1945; Scagel, 1957
Alaska to La Jolla, Calif.; Galapagos Arch.

Antithamnion pacificum (Harvey) Kylin

Dawson, 1954; Scagel, 1957
Yakutat Bay, Alaska, to La Jolla, Calif.; northern Gulf of Calif.

Antithamnion pulchellum Gardner

Gardner, 1927*c*
Santa Monica, Calif.

Antithamnion pygmaeum Gardner

Doty, 1947; Dawson, 1949; Dawson, Neushul & Wildman, 1960*a*
Oreg. to Punta Eugenio, Baja Calif.

Antithamnion secundatum Gardner

Gardner, 1927*c*
San Diego, Calif.

Antithamnion setaceum Gardner

Gardner, 1927*c*
San Diego, Calif.

Antithamnion simulans Gardner

Gardner, 1927*b*
Sitka, Alaska

Antithamnion sublittorale Setchell & Gardner

Dawson, 1954
San Jose del Cabo, Baja Calif.

Antithamnion subulatum (Harvey) J. Agardh

Scagel, 1957
Southern British Columbia to Monterey, Calif.

Antithamnion uncinatum Gardner

Scagel, 1957
Northern Wash. to Carmel, Calif.

Antithamnion veleroae Taylor

Taylor, 1945
Galapagos Arch.

Platythamnion heteromorphum (J. Agardh) J. Agardh

Doty, 1947
Oreg. to San Pedro, Calif.

Platythamnion pectinatum Kylin var. *pectinatum*

Dawson, 1954; Scagel, 1957
Hope I., British Columbia, to Cabo Colnett, Baja Calif.

Platythamnion pectinatum var. *laxum* Taylor

Dawson, 1954
Isla Clarión, Revillagigedo Arch.

Platythamnion reversum (Setchell & Gardner) Kylin var. *reversum*

Scagel 1957
Northern Wash. to Oreg.

Platythamnion reversum var. *laxum* Taylor

Taylor, 1945
Galapagos Arch.

Platythamnion tepocensis Dawson

Dawson, 1954
Bahía Tepoca, Gulf of Calif.

Platythamnion villosum Kylin

Dawson, 1954; Scagel, 1957; Dawson, Neushul & Wildman, 1960*a*
Sitka, Alaska, to Bahía Tortuga, Baja Calif.

Ceramium affine Setchell & Gardner var. *affine*

Taylor, 1945; Dawson, 1954
Isla Guadalupe, Baja Calif.; Isla Ángel de la Guarda, Gulf of Calif.; Guayas, Ecuador

Ceramium affine var. *peninsularis* Dawson

Dawson, 1954
Corona del Mar, Calif.; Scammon Lagoon, Baja Calif.; Punta Frailes, Gulf of Calif.

Ceramium avalonae Dawson

Dawson, 1954, 1960*a*
Santa Catalina I., Calif.; Isla Guadalupe, Baja Calif.; Puerto Culebra; Bahía Potrero Grande, Costa Rica

Ceramium californicum J. Agardh

Dawson, 1954, 1959*c*; Scagel, 1957
Southern British Columbia to Bahía Magdalena, Baja Calif.

Ceramium camouii Dawson

Dawson, 1954, 1957
Punta Banda; Bahía Vizcaino; Rocas Alijos, Baja Calif.; Gulf of Calif.

Ceramium caudatum Setchell & Gardner

Dawson, 1954, 1959
Balboa Harbor; Santa Catalina I., Calif.; Isla Guadalupe Baja Calif.; Gulf of Calif.

Ceramium clarionense Setchell & Gardner

Dawson, 1954, 1957
Balboa Harbor, Calif., to Isla Cedros; Rocas Alijos, Baja Calif.; Isla Jorge, Gulf of Calif. to Miramar, Nayarit; Revillagigedo Arch.

Ceramium codicola J. Agardh

Dawson, 1954; Scagel, 1957
Sitka, Alaska, to Bahía Tortuga, Baja Calif.

Ceramium eatonianum (Farlow) J. B. De Toni

Doty, 1947: Dawson, 1954, 1959*c*
Coos Bay, Oreg. to Isla Magdalena, Baja Calif.

Ceramium equisetoides Dawson

Dawson, 1954, 1957*b*
Balboa Harbor, Calif.; Bahía Tepoca, Sonora to Mazatlán, Sinaloa; Golfo de Nicoya, Costa Rica

Ceramium evermannii Setchell & Gardner

Dawson, 1954
Isla Guadalupe, Baja Calif.

Ceramium fimbriatum Setchell & Gardner

Dawson, 1954, 1959
Punta Banda to Cabeza Ballena, Baja Calif.; Isla Ángel de la Guarda, Gulf of Calif. to Acapulco, Guerrero

Ceramium gardneri Kylin

Doty, 1947; Dawson, 1950*d*
Coos Bay, Oreg., to Santa Cruz I. and Ventura, Calif.

Ceramium gracillimum var. *byssoideum* (Harvey) G. Mazoyer

Dawson, 1950*d*, 1954 (both as *C. masonii*), 1956, 1957*b*, 1959; Taylor, 1945 (as *C. byssoideum*)
Corona del Mar, Calif., to Cabeza Ballena, Baja Calif.; Gulf of Calif.; Costa Rica; Galapagos Arch.

Ceramium hamatispinum Dawson

Dawson, 1954
Miramar, Nayarit

Ceramium hoodii Taylor

Taylor, 1945
Galapagos Arch.

Ceramium horridum Setchell & Gardner

Dawson, 1954
Gulf of Calif.

Ceramium howellii Setchell & Gardner

Setchell & Gardner, 1937; Dawson, 1957
Galapagos Arch.

Ceramium marshallense Dawson

Dawson, 1957*b*
Golfo de Nicoya, Costa Rica

Ceramium mazatlanense Dawson

Dawson, 1954, 1954*c*, 1957*b*, 1959*b*
Kino, Sonora, to Salina Cruz, Oaxaca; Golfo Dulce, Costa Rica; Isla San Benedicto, Revillagigedo Arch.; Clipperton I. ?

Ceramium nakamurai Dawson

Dawson, 1957*b*
Golfo de Nicoya, Costa Rica

Ceramium obesum Dawson

Dawson, 1954
Bahía Agua Dulce, Isla Tiburón, Sonora

Ceramium ornatum Setchell & Gardner

Dawson, 1954
Isla Guadalupe, Baja Calif.

Ceramium pacificum (Collins) Kylin

Scagel, 1957; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Northern British Columbia to Punta María, Baja Calif.

Ceramium paniculatum Okamura

Dawson, 1954, 1959
Guaymas, Sonora, to Mazatlán, Sinaloa

Ceramium personatum Setchell & Gardner

Taylor, 1945; Dawson, 1954
Isla Guadalupe; vicinity of Punta Santa Rosalía, Baja Calif.; Puerto Parker, Costa Rica ?

Ceramium procumbens Setchell & Gardner

Hollenberg, 1948; Dawson, 1954, 1959, 1960*a*
Southern Calif. to Punta Santa Rosalía, Baja Calif.; Gulf of Calif.; Bahía Ballena, Costa Rica

Ceramium recticorticum Dawson

Dawson, 1954
Guaymas, Sonora; Mazatlán, Sinaloa

Ceramium rubrum (Hudson) C. Agardh

Scagel, 1957
Bering Sea to northern Wash.

Ceramium serpens Setchell & Gardner

Dawson, 1949*a*, 1954, 1957
Gulf of Calif.; Clipperton I. ?; Galapagos Arch. ?

Ceramium sinicola Setchell & Gardner var. *sinicola*

Dawson, 1954, 1957, 1959
Southern Calif. and Pacific Baja Calif.; Rocas Alijos; Isla San Benedicto, Revillagigedo Arch.; northern Gulf of Calif.

Ceramium sinicola var. *interrupta* (Setchell & Gardner) Dawson

Hollenberg, 1948; Dawson, 1954, 1959
Same range as the species

Ceramium sinicola var. *johnstonii* (Setchell & Gardner) Dawson

Dawson, 1954
Same range as the species

Ceramium strictum Harvey

Dawson, 1950*c* (as probably referable to *C. gardneri*); Scagel, 1957
Southern British Columbia

Ceramium taylorii Dawson

Taylor, 1945 (as *C. fastigiatum*); Dawson, 1954, 1954*c*, 1957*b*, 1959
Laguna Beach, Calif., to Bahía Magdalena, Baja Calif.; Gulf of Calif. to Acapulco, Guerrero; Isla San Benedicto, Revillagigedo Arch.; Golfo de Nicoya, Costa Rica; Galapagos Arch. ?

Ceramium templetonii Setchell & Gardner

Setchell & Gardner, 1937; Dawson, 1957
Galapagos Arch.

Ceramium vagabunde Dawson

Dawson, 1954*c* (as *Ceramium* sp.), 1957*a*, 1957*b*
Isla San Benedicto, Revillagigedo Arch.; Golfo Dulce, Costa Rica

Ceramium viscainoense Dawson

Dawson, 1954
Punta Santa Rosalía, Baja Calif.

Ceramium zacae Setchell & Gardner

Dawson, 1954, 1957, 1959; Dawson, Neushul & Wildman, 1960*a*
Southern Calif. to Rocas Alijos; Punta Abreojos, Baja Calif.; Bahía Agua Verde, Gulf of Calif.

Centroceras bellum Setchell & Gardner

Dawson, 1954
Guaymas, Sonora

Centroceras clavulatum (C. Agardh) Montagne var. *clavulatum*

Dawson, 1954, 1954*c*, 1957, 1957*b*, 1959, 1959*c*; Taylor, 1945
Santa Cruz, Calif., to Panamá; Galapagos Arch.

Centroceras clavulatum var. *inerme* (Kützing) Piccone

Dawson, 1957
Galapagos Arch.

Centroceras minutum Yamada

Dawson, 1960*a*
Isla Brincanco, Panamá

Microcladia borealis Ruprecht

Okamura, 1933; Scagel, 1957
Aleutian Islands, Alaska, to San Simeon, Calif.

Microcladia californica Farlow

Smith, 1944
San Francisco to San Diego, Calif.

Microcladia coulteri Harvey

Dawson, 1954, 1959*c*, Scagel, 1957; Dawson, Neushul & Wildman, 1960
Vancouver I., British Columbia, to Punta Santa Rosalía, Baja Calif.

Neoptilota asplenioides (Esper) Kylin

Kylin, 1956; Scagel, 1957 (as *Ptilota asplenioides*)
Yakutat Bay, Alaska, to Puget Sound, Wash.

Neoptilota californica (Ruprecht) Kylin

Kylin, 1956; Scagel, 1957 (as *Ptilota californica*)
Northern British Columbia to San Diego, Calif.

Neoptilota densa (C. Agardh) Kylin

Kylin, 1956; Dawson, 1954 (as *Plumaria densa*); Smith, 1944; Dawson, 1945*b* both as *Ptilota densa*)
Tomales Bay, Calif., to Punta Baja, Baja Calif.

Neoptilota hypnoides (Harvey) Kylin

Kylin, 1956; Scagel, 1957 (as *Ptilota hypnoides*)
Sitka, Alaska, to San Luis Obispo Co., Calif.

Ptilota filicina (Farlow) J. Agardh

Kylin, 1956; Scagel, 1957; Dawson, 1954 (as *Plumaria filicina*); Dawson, 1949*a*, 1959*c* (both as *Ptilota filicina*)
Bering Sea to Cabo Colnett, Baja Calif.

Ptilota pectinata (Gunner) Kjellman

Kylin, 1956; Scagel, 1957
Bering Sea to Puget Sound, Wash.

Ptilota tenuis Kylin

Kylin, 1956; Scagel, 1957
Northern British Columbia to northern Wash.

Spyridia filamentosa (Wulfen) Harvey

Kylin, 1941; Taylor, 1945; Dawson, 1954, 1957*b*
Southern Calif. to Panamá

Wrangelia argus (Montagne) Montagne

Dawson, 1960*a*
Punta Naranja, Panamá

Callithamnion acutum Kylin

Scagel, 1957
Northern Wash.

Callithamnion arborescens Gardner

Gardner, 1927*b*
Sitka, Alaska

Callithamnion biseriatum Kylin

Scagel, 1957
Northern British Columbia to Monterey, Calif.

Callithamnion bisporum Gardner

Scagel, 1957
Northern Wash.

Callithamnion breviramosum Gardner

Gardner, 1927*c*
La Jolla, Calif.

Callithamnion byssoides Arnott

Dawson, 1954, 1960*a*
Isla Guadalupe, Baja Calif.

Callithamnion californicum Gardner

Smith, 1944
Monterey Peninsula, Calif.

Callithamnion ecuadoreanum Taylor

Taylor, 1945
Galapagos Arch.

Callithamnion endovaginum Setchell & Gardner

Kylin, 1941; Dawson, 1944, 1954
La Jolla, Calif.; Guaymas, Sonora

Callithamnion epiphyticum Taylor

Taylor, 1945
Galapagos Arch.

Callithamnion laxum Setchell & Gardner

Scagel, 1957
Southern British Columbia and northern Wash.; Oreg.

Callithamnion marshallense Dawson

Dawson, 1960*a*
Bahía Uvita, Costa Rica

Callithamnion pacificum Taylor

Dawson, 1954
Isla Socorro, Revillagigedo Arch.

Callithamnion paschale Børgesen

Dawson, 1957, 1959
Isla San Benedicto, Revillagigedo Arch. ?; Gulf of Calif.

Callithamnion pikeanum Harvey var. *pikeanum*

Scagel, 1957; Dawson, 1959*c*
Vallenar Point, Alaska, to Point Dume, Calif.

Callithamnion pikeanum var. *pacificum* (Harvey) Setchell & Gardner

Scagel, 1957
Shumagin I., Alaska, to Oreg.; Point Mugu, Calif.

Callithamnion ramosissimum Gardner

Gardner, 1927*c*; Dawson, 1949
Santa Catalina I., La Jolla, Calif.

Callithamnion rupicolum Anderson f. *rupicolum*

Smith, 1944; Dawson, 1954
Fort Ross, Calif., to Isla Magdalena, Baja Calif.

Callithamnion rupicolum f. *pygmaeum* Collins in Collins, Holden & Setchell

Collins, Holden & Setchell, 1911 (P.B.A. 1797); Dawson, 1949; Taylor, 1945 (as possibly *C. rupicolum* f. *pygmaeum*)
Santa Catalina I., Calif.; Galapagos Arch.

Callithamnion socorriense Taylor

Dawson, 1954
Isla Socorro, Revillagigedo Arch.

Callithamnion squarrulosum Harvey

Harvey, 1853; J. Agardh, 1876
Golden Gate (San Francisco) Calif.

Callithamnion varispiralis Dawson

Dawson, 1954
Santa Catalina I., Calif.; Bahía Vizcaino, Baja Calif.

Haloplegma mexicanum Taylor

Dawson, 1954
Isla María Magdalena, Nayarit

Pleonosporium abysicola Gardner

Scagel, 1957
Near Friday Harbor, Wash.

Pleonosporium complanatum Taylor

Taylor, 1945
Galapagos Arch.

Pleonosporium dasyoides (J. Agardh) J. B. De Toni

Dawson, 1954, 1959*c*
Tomales Bay, Calif., to Punta Descanso, Baja Calif.

Pleonosporium globuliferum Levring

Dawson, 1957*b*, 1960*a*
Puerto Guatulco, Oaxaca; Golfo de Nicoya, Costa Rica

Pleonosporium kobayashii Okamura

Okamura 1933
Atka I., Aleutian Islands, Alaska

Pleonosporium polycarpum Gardner

Gardner, 1927*b*
La Jolla, Calif.

Pleonosporium pygmaeum Gardner

Gardner, 1927*b*
La Jolla, Calif.

Pleonosporium squarrosum Kylin var. *squarrosum*

Scagel, 1957
Southern British Columbia to Northern Wash.

Pleonosporium squarrosum var. *obovatum* Gardner

Scagel, 1957
Sidney, Vancouver I., British Columbia

Pleonosporium vancouverianum (J. Agardh) J. Agardh

Scagel, 1957
Northern British Columbia to Monterey, Calif.

Griffithsia (?) *anthericephala* Dawson

Dawson, 1954
Isla Guadalupe, Baja Calif.

Griffithsia multiramosa (Setchell & Gardner) Taylor var. *multiramosa*

Dawson 1945*b*, 1954
San Diego, Calif.; Isla Guadalupe; Scammon Lagoon; San Ignacio Lagoon, Baja Calif.; Gulf of Calif.

Griffithsia multiramosa var. *balboensis* Hollenberg

Hollenberg, 1945
Balboa Harbor, Calif.

Griffithsia multiramosa var. *minor* Taylor

Dawson, 1954
Punta Gorda, Baja Calif. del Sur

Griffithsia pacifica Kylin

Scagel, 1957; Dawson, 1954; Dawson, Neushul & Wildman, 1960
Southern British Columbia to southern Baja Calif.; northern Gulf of Calif.; Revillagigedo Arch. ?; Galapagos Arch.

Griffithsia tenuis C. Agardh

Dawson, 1954, 1959
Scammon Lagoon, Baja Calif.; Punta Peñasco, Sonora, to Mazatlán, Sinaloa

Spermothamnion phycophilum Taylor

Taylor, 1945
Galapagos Arch.

Spermothamnion snyderae Farlow

Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Bolinas, Calif., to Isla Magdalena, Baja Calif.; northern Gulf of Calif.

Tiffaniella saccorhiza (Setchell & Gardner) Doty & Meñez

Doty & Meñez, 1960; Dawson, 1954 (as *Spermothamnium saccorhiza*)
Isla Guadalupe; Bahía Vizcaino, Baja Calif.

FAM. DELESSERIACEAE

Caloglossa leprieurii (Montagne) J. Agardh

Taylor, 1945; Dawson, 1957*b*
Golfo Dulce, Costa Rica; Bahía Buenaventura, Colombia; Galapagos Arch.; Bahía San Francisco, Ecuador

Branchioglossum undulatum Dawson

Dawson, 1949, 1960*a*; Dawson, Neushul & Wildman, 1960, 1960*a*
Santa Rosa I., Calif., to Punta Asunción, Baja Calif.; Bahía Santiago, Colima

Branchioglossum woodii (J. Agardh) Kylin

Dawson, 1954, 1957, 1959; Scagel, 1957
Vancouver I., British Columbia, to Bahía Vizcaino, Baja Calif.; Rocas Alijos; Gulf of Calif.

Hypoglossum abyssicolum Taylor

Dawson, 1954
Islas Las Tres Marías, Nayarit; Puerto Culebra, Costa Rica; Isla Gorgona, Colombia; Galapagos Arch.

Hypoglossum attenuatum Gardner

Dawson, 1954
Isla Guadalupe; San Ignacio Lagoon, Baja Calif.; northern Gulf of Calif.

Hypoglossum retusum Dawson

Dawson, 1954; Dawson, Neushul & Wildman, 1960*a*
Isla Cedros; near Punta Eugenio, Baja Calif.

Hemineura (?) *bowellii* Taylor

Taylor, 1945
Galapagos Arch.

Membranoptera denticulata (Montagne) Kylin

Kylin, 1924; Setchell & Gardner, 1903 (as *Pteridium spinulosum*)
Bering Sea to Morzhovoi Bay, Alaska

Membranoptera dimorpha Gardner

Scagel, 1957
Queen Charlotte I., British Columbia, to Coos Bay, Oreg.

Membranoptera multiramosa Gardner

Doty, 1947
Oreg. to Monterey, Calif.

Membranoptera platyphylla (Setchell & Gardner) Kylin

Scagel, 1957
Southern British Columbia to Oreg.

Membranoptera setchellii Gardner

Gardner, 1926
Morzhovoi Bay, Alaska

Membranoptera spatulata Dawson

Dawson ,1954
Isla Patos, Sonora

Membranoptera tenuis Kylin

Scagel, 1957
Northern Wash.

Membranoptera weeksiae Setchell & Gardner

Scagel, 1957
Northern Wash.; San Francisco to San Diego, Calif.

Pantoneura baerii (Ruprecht) Kylin

Kylin, 1924
Sitka, Alaska

Pantoneura juergensii (J. Agardh) Kylin

Kylin, 1924
Bering Sea to Unalaska, Alaska

Holmesia californica (Dawson) Dawson

Scagel, 1957
Northern Wash.; San Diego, Calif.

Schizoseris pygmaea Dawson

Dawson, 1954, 1959
Northern Gulf of Calif.

Delesseria decipiens J. Agardh

Scagel, 1957
Prince William Sound, Alaska, to Carmel, Calif.

Delesseria hancockii Taylor

Taylor, 1945
Galapagos Arch.

Platysiphonia clevelandii (Farlow) Papenfuss

Scagel, 1957
Northern Wash. to San Diego, Calif.

Platysiphonia parva Silva & Cleary

Silva & Cleary, 1954; Dawson, 1954
Isla Guadalupe, Baja Calif.

Taenioma perpusillum J. Agardh

Dawson, 1954, 1959, 1960*a*
Gulf of Calif.; Isla Brincanco, Panamá

Erythroglossum californicum (J. Agardh) J. Agardh

Doty, 1947; Dawson, 1958
Oreg.; Monterey to Ventura, Calif.

Erythroglossum intermedium (J. Agardh) Kylin

Scagel, 1957
Vancouver I., British Columbia

Sorella delicatula (Gardner) Hollenberg var. *delicatula*

Hollenberg, 1943
San Pedro, Calif.

Sorella delicatula var. *californica* Hollenberg

Hollenberg, 1943
Southern Calif.

Sorella divaricata (Setchell & Gardner) Hollenberg

Hollenberg, 1943; Smith, 1944 (as *Erythroglossum divaricata*)
Pacific Grove, Calif.

Sorella pinnata Hollenberg

Dawson, 1954
Southern Calif.; Islas San Benito, Baja Calif.; Gulf of Calif.

Grinnellia lanceolata Dawson

Dawson, 1954, 1959*c*
Punta Gorda, Baja Calif. del Sur

Polyneura latissima (Harvey) Kylin

Scagel, 1957; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960, 1960*a*
Northern British Columbia to Punta Eugenio, Baja Calif.

Polyneurella hancockii Dawson

Dawson, 1954
Isla Angel de la Guarda, Gulf of Calif.

Nienburgia andersoniana (J. Agardh) Kylin

Doty, 1947; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Oreg.; Santa Cruz, Calif., to Isla Magdalena, Baja Calif.

Nienburgia borealis (Kylin) Kylin

Scagel, 1957
Southern British Columbia to northern Wash.

Phycodrys ambigua Gardner

Gardner, 1927*a*
Sitka, Alaska

Phycodrys bullata Gardner

Gardner, 1927*a*
Agattu I., to Sitka, Alaska

Phycodrys elegans Setchell & Gardner

Setchell & Gardner, 1937; Taylor, 1945
Galapagos Arch.

Phycodrys pulchra Taylor

Taylor, 1945 (as probably equal to *P. elegans*)
Galapagos Arch.

Phycodrys setchellii Skottsberg

Doty, 1947; Dawson, 1954, 1959*c*
Oreg. to Isla Cedros, Baja Calif.

Pseudophycodrys rainosukei Tokida

Okamura, 1933
Atka I., Aleutian Islands, Alaska

Polycoryne gardneri Setchell

Scagel, 1957
Northern Wash. to Monterey, Calif.

Polycoryne phycodricola Dawson

Dawson, 1954
Isla Cedros, Baja Calif.

Haraldia prostrata Dawson, Neushul & Wildman

Dawson, Neushul & Wildman, 1960*a*
Islas San Benito, Baja Calif.

Anisocladella pacifica Kylin

Smith, 1944; Hollenberg, 1948; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Santa Cruz, Calif., to Bahía Asunción, Baja Calif.

Myriogramme caespitosa Dawson

Dawson, 1949; Dawson, Neushul & Wildman, 1960, 1960*a*
Santa Rosa I., Calif., to Isla Magdalena, Baja Calif.

Myriogramme divaricata Dawson

Dawson, 1954
Isla Ángel de la Guarda, Gulf of Calif.

Myriogramme hollenbergii Kylin

Smith, 1944; Dawson, 1954, 1958
Monterey; La Jolla, Calif.; Isla Magdalena, Baja Calif.

Myriogramme kylinii Taylor

Taylor, 1945
Galapagos Arch.

Myriogramme osorioi Dawson

Dawson, 1954
Isla Patos; Isla Partida, northern Gulf of Calif.

Myriogramme pulchra Gardner

Scagel, 1957
Northern Wash.

Myriogramme repens Hollenberg

Hollenberg, 1945
Point Vicente, Calif.

Myriogramme spectabilis (Eaton) Kylin

Dawson, 1954; Scagel, 1957
Northern Wash. to Socorro, Baja Calif.

Acrosorium (?) *fragile* Taylor

Taylor, 1945
Galapagos Arch.

Acrosorium papenfussii Taylor

Taylor, 1945
Galapagos Arch.

Acrosorium uncinatum (Turner) Kylin

Kylin, 1941; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Southern Calif. to Bahía Santa María, Baja Calif.

Nitophyllum divaricatum Taylor

Taylor, 1945
Galapagos Arch.

Nitophyllum galapagense Taylor

Taylor, 1945
Galapagos Arch.

Nitophyllum mirabile Kylin

Scagel, 1957
Southern British Columbia to northern Wash.

Hymenena cuneifolia Doty

Doty, 1947
Coos Bay, Oreg

Hymenena flabelligera (J. Agardh) Kylin

Scagel, 1957
Southern British Columbia to Carmel, Calif.

Hymenena kylinii Gardner

Doty, 1947
Oreg.; San Francisco to Monterey, Calif.

Hymenena multiloba (J. Agardh) Kylin

Doty, 1947
Oreg. to Carmel, Calif.

Hymenena setchellii Gardner

Scagel, 1957
Hope I., British Columbia, to Carmel, Calif.

Hymenena smithii Kylin

Doty, 1947
Oreg.; Carmel, Calif.

Cryptopleura brevis Gardner

Doty, 1947
Oreg.; Moss Beach, Calif.

Cryptopleura corallinara (Nott) Gardner

Dawson, 1954, 1957, 1959*c*; Dawson, Neushul & Wildman, 1960*a*
San Diego, Calif., to Isla Magdalena; Rocas Alijos, Baja Calif.

Cryptopleura crispa Kylin

Kylin, 1941; Doty, 1947; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Oreg.; Ventura Co., Calif., to Isla Magdalena, Baja Calif.

Cryptopleura dichotoma Gardner

Gardner, 1927
San Pedro, Calif.

Cryptopleura lobulifera (J. Agardh) Kylin

Smith, 1944; Dawson, 1949, 1954, 1959*c*
Tomales Bay, Calif., to Bahía Santa María, Baja Calif.

Cryptopleura ruprechtiana (J. Agardh) Kylin

Scagel, 1957
Sitka, Alaska, to northern Calif.

Cryptopleura spatulata Gardner

Gardner, 1927; Dawson, 1960*a*
Santa Barbara; San Pedro, Calif.; Islas Todos Santos, Baja Calif.

Cryptopleura violacea (J. Agardh) Kylin

Scagel, 1957; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Southern Vancouver I., British Columbia, to near Punta María, Baja Calif.

Botryoglossum farlowianum (J. Agardh) J. B. De Toni

Scagel, 1957 Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960, 1960*a*
Puget Sound, Wash., to Islas San Benito, Baja Calif.

Gonimophyllum skottsbergii Setchell

Scagel, 1957
Friday Harbor, Wash., to San Diego, Calif.

FAM. DASYACEAE

Dasya abyssicola Dawson

Dawson, 1949
San Clemente Is., Calif.

Dasya californica Gardner

Dawson, 1945*b*, 1954
Southern Calif. to Isla Magdalena, Baja Calif.

Dasya eastwoodae Setchell & Gardner

Dawson, 1954
Isla Guadalupe, Baja Calif.

Dasya pedicellata C. Agardh

Dawson, 1954, 1957, 1959
Rocas Alijos; central Baja Calif.; northern Gulf of Calif.

Dasya sinicola (Setchell & Gardner) Dawson

Dawson, 1959
Southern Gulf of Calif.

Dasya stanfordiana Farlow

Taylor, 1945; Dawson, 1954
Isla Guadalupe, Baja Calif.; Islas Tres Marías, Nayarit; Galapagos Arch.

Rhodoptilum densum (G. M. Smith) comb. nov.

Smith, in Smith & Hollenberg, 1943; 217; Smith, 1944; Hollenberg, 1948 (all as *Dasyopsis densa*)
Santa Cruz, Calif., to southern Calif.

Rhodoptilum plumosum (Harvey & Bailey) Kylin

Kylin, 1956; Scagel, 1957 (as *Dasyopsis plumosa*)
Queen Charlotte Sound, British Columbia, to northern Calif.

Pogonophorella californica (J. Agardh) Silva

Hollenberg, 1948; Dawson, 1945*b* (both as *Pogonophora*), 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Santa Barbara, Calif., to Bahía Asunción, Baja Calif.

Heterosiphonia asymmetria Hollenberg

Hollenberg, 1945
Corona del Mar, Calif.

Heterosiphonia densiuscula Kylin

Scagel, 1957
Northern Wash.

Heterosiphonia erecta Gardner, em. Setchell & Gardner

Dawson, 1949, 1954, 1957; Taylor, 1945
Santa Monica, Calif., to Rocas Alijos; Isla Magdalena, Baja Calif.; Guayas, Ecuador

Heterosiphonia laxa Kylin

Scagel, 1957
Southern British Columbia to northern Wash.

Heterosiphonia wurdemannii var. *laxa* Børgesen

Dawson, 1957*b*, 1959
Isla Espíritu Santo, Gulf of Calif.; Golfo de Nicoya, Costa Rica

FAM. RHODOMELACEAE

Polysiphonia acuminata Gardner

Hollenberg, 1942*a*; Smith, 1944
Monterey to La Jolla, Calif.

Polysiphonia bajacali Hollenberg

Hollenberg, 1961
Isla Guadalupe, Baja Calif.

Polysiphonia beaudettei Hollenberg

Hollenberg, 1961
Isla Guadalupe; Scammon Lagoon, Baja Calif.; Isla Socorro, Revillagigedo Arch.; Isla Grande, Guerrero; Bahía Potrero Grande, Costa Rica

Polysiphonia bifurcata Hollenberg

Taylor, 1945; Hollenberg, 1961
Scammon Lagoon, Baja Calif.; Playa Blanca, Costa Rica; Galapagos Arch.

Polysiphonia brodiaei (Dillwyn) Greville

Hollenberg, 1944; Smith, 1944
Sausalito to Santa Monica, Calif.

Polysiphonia confusa Hollenberg

Hollenberg, 1961; Dawson, 1959*c* (as *P. inconspicua*)
Corona del Mar, Calif., to Desembarcadero de Miller, Baja Calif.

Polysiphonia decussata Hollenberg

Hollenberg, 1961; Taylor, 1945
Topanga Canyon, Calif., to near Punta Malarrino, Baja Calif.; Isla Guadalupe; Galapagos Arch.

Polysiphonia ferulacea Suhr

Dawson, 1957
Clipperton I.

Polysiphonia flaccidissima Hollenberg var. *flaccidissima*

Hollenberg, 1961
Laguna Beach, Calif., to Panamá

Polysiphonia flaccidissima var. *smithii* Hollenberg

Hollenberg, 1942*a*; Smith, 1944
San Francisco to San Diego, Calif.

Polysiphonia guadalupensis Setchell & Gardner

Hollenberg, 1961
Isla Guadalupe, Baja Calif.

Polysiphonia hancockii Dawson

Hollenberg, 1961
Cabeza Ballena to San Jose del Cabo, Baja Calif. del Sur

Polysiphonia hendryi Gardner var. *hendryi*

Doty, 1947; Hollenberg, 1961
Cape Arago, Oreg., to Isla Cedros, Baja Calif.

Polysiphonia hendryi var. *gardneri* (Kylin) Hollenberg

Scagel, 1957; Dawson, 1959*c* (both as *P. collinsii*); Hollenberg, 1961
British Columbia to Cabo San Lucas, Baja Calif.

Polysiphonia hendryi var. *compacta* (Hollenberg) Hollenberg

Hollenberg, 1961
Southern Calif. and northern Baja Calif.

Polysiphonia hendryi var. *deliquescens* (Hollenberg) Hollenberg

Scagel, 1957 (as *P. collinsii* var. *deliquescens*); Hollenberg, 1961
Prince William Sound, Alaska, to Oreg.

Polysiphonia hendryi var. *luxurians* (Hollenberg) Hollenberg

Scagel, 1957 (as P. *collinsii* var. *luxurians;* Hollenberg, 1961
Northern Wash.

Polysiphonia homia Setchell & Gardner

Hollenberg, 1961
Isla Guadalupe, Baja Calif.

Polysiphonia howei Hollenberg

Taylor, 1955; Hollenberg, 1958*a*
Bahía de Panamá, Panamá; Bahía Cobita, Colombia

Polysiphonia indigena Hollenberg

Hollenberg, 1958*a*, 1944 (as *P. dichotoma*)
Santa Cruz; San Diego, Calif.

Polysiphonia johnstonii Setchell & Gardner var. *johnstonii*

Dawson, Neushul & Wildman, 1960*a*; Hollenberg, 1961
Santa Catalina I., Calif., to Topolobampo, Sinaloa; Gulf of Calif.

Polysiphonia johnstonii var. *concinna* (Hollenberg) Hollenberg

Hollenberg, 1961
La Jolla, Calif., to Mazatlán, Sinaloa; Gulf of Calif.

Polysiphonia macounii Hollenberg

Scagel, 1957
Southern British Columbia

Polysiphonia masonii Setchell & Gardner

Hollenberg, 1961
Isla Guadalupe, Baja Calif.

Polysiphonia mollis Hooker & Harvey

Dawson, 1959*c*; Scagel, 1957 (both as *P. snyderae*); Hollenberg, 1961; Dawson, 1957; 1957*b*, 1959*b*; Dawson, Neushul & Wildman, 1960
Southern British Columbia to central Mexico

Polysiphonia nathanielii Hollenberg

Hollenberg, 1961
Santa Monica, Calif., to Playa Rosarita, Baja Calif.

Polysiphonia pacifica var. *pacifica*

Doty, 1947; Dawson, 1959*c*; Hollenberg, 1961
Sitka, Alaska, to Islas Coronados, Baja Calif.

Polysiphonia pacifica var. *delicatula* Hollenberg

Hollenberg, 1961
Monterey, Calif., to Bahía Cahuacán, Chiapas; central Gulf of Calif.

Polysiphonia pacifica var. *determinata* Hollenberg

Scagel, 1957
Alaska to central Calif.

Polysiphonia pacifica var. *distans* Hollenberg

Scagel, 1957
Southern British Columbia to Santa Cruz, Calif.

Polysiphonia pacifica var. *disticha* Hollenberg

Hollenberg, 1942*a*; Scagel, 1957; Segi, 1951 (as *P. abscissa*)
Vancouver I., British Columbia, to central Calif.

Polysiphonia pacifica var. *gracilis* Hollenberg

Scagel, 1957
Southern British Columbia to central Calif.

Polysiphonia paniculata Montagne

Scagel, 1957; Dawson, 1959*c*; Hollenberg, 1961; Dawson, Neushul & Wildman, 1960*a*
Port Holmes, British Columbia, to Punta Baja, Baja Calif.; northern Gulf of Calif.

Polysiphonia savatieri Hariot

Hollenberg, 1961; Dawson, 1945*b* (as *P. minutissima*)
Santa Catalina I., Calif., to Isla Guadalupe; Punta Banda, Baja Calif.

Polysiphonia senticulosa Harvey

Scagel, 1957
Southern British Columbia to Monterey, Calif.

Polysiphonia simplex Hollenberg

Hollenberg, 1961; Dawson, 1959*c*
Southern Calif. to Costa Rica; Gulf of Calif.; Revillagigedo Arch.

Polysiphonia sonorensis Hollenberg

Hollenberg, 1961
Guaymas; Empalme, Sonora

Polysiphonia subtilissima Montagne (fide Tseng)

Dawson, 1957*b*, 1959*b*
Costa Rica; Clipperton I.

Polysiphonia urceolata (Lightfoot) Greville

Okamura, 1933; Segi, 1951; Scagel, 1957
Aleutian I., Alaska, to northern Wash.

Tayloriella dictyurus (J. Agardh) Kylin

Kylin, 1956; Dawson, 1954 (as *Bryocladia dictyurus*)
Bahía Petatlán, Guerrero; Pochetti, Oaxaca ?

Bryocladia borealis Dawson

Dawson, 1954
Campo Malarrimo, Bahía Vizcaino, Baja Calif.

Ophidocladus californica (Hollenberg) Kylin

Kylin, 1956; Dawson, 1960*a*; Hollenberg, 1943 (as *Rhodosiphonia*)
Santa Barbara to San Diego, Calif.

Digenia simplex (Wulfen) C. Agardh

Dawson, 1954, 1957*b*, 1959
Gulf of Calif. to Costa Rica

Bryothamnion pacificum Taylor

Dawson, 1954
Bahía Vizcaino, Baja Calif.; Isla María Magdalena, Nayarit

Bostrychia binderi Harvey

Taylor, 1945; Dawson, 1957*b*
Golfo Dulce, Costa Rica; Galapagos Arch.

Bostrichia calliptera (Montagne) Montagne

Taylor, 1945
Panamá; Choco, Bahía Buenaventura; Isla Gorgona, Colombia; Galapagos Arch.

Bostrychia radicans Montagne

Taylor, 1945; Dawson, 1954, 1957*b*; Post 1955 (as *B. radicans* f. *moniliforme*)
Guaymas, Sonora; Barra de Navidad, Jalisco; El Salvador; Golfo Dulce, Costa Rica; Choco, Bahía Buenaventura, Colombia; Galapagos Arch.

Bostrychia simpliciuscula Harvey ex J. Agardh

Dawson, 1957*b*
Golfo de Nicoya, Costa Rica

Bostrychia tenella J. Agardh

Taylor, 1945
Galapagos Arch.

Lophosiphonia macra (Harvey) Falkenberg

Dawson, 1954*c*
Isla San Benedicto, Revillagigedo Arch.

Lophosiphonia mexicana Dawson

Dawson, 1954
Isla Cedros, Baja Calif.; Isla Ángel de la Guarda, Gulf of Calif.; Isla Clarión, Revillagigedo Arch.

Lophosiphonia reptabunda (Suhr) Kylin

Kylin, 1956; Dawson, 1957*b*, 1959*c* (possibly confused with *Ophidocladus*); Scagel, 1957 (as *L. obscura*); Hollenberg, 1958*a* (as *L. obscura*)
Southern British Columbia to northern Wash.; southern Calif. ?; Costa Rica ?

Lophosiphonia scopulorum (Harvey) Womersley

Dawson, 1957*b*, 1959, 1959*c*, 1954 (as *L. villum*); Scagel, 1957 (as *L. villum*)
Southern British Columbia to Isla Magdalena, Baja Calif.; Gulf of Calif.

Brogniartella mucronata (Harvey) Schmitz

Dawson, 1954; Kylin, 1956 (as probably a species of *Micropeuce*)
Isla María Magdalena, Nayarit

Veleroa subulata Dawson

Dawson, 1954
Bahía Tepoca, Sonora

Pterosiphonia arctica Setchell & Gardner

Okamura, 1933; Scagel, 1957
Aleutian I., Alaska, to Puget Sound, Wash.

Pterosiphonia baileyi (Harvey) Falkenberg

Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Crescent City, Calif., to Isla San Roque, Baja Calif.

Pterosiphonia bipinnata (Postels & Ruprecht) Falkenberg var. *bipinnata*

Okamura, 1933; Scagel, 1957
Aleutian I., Alaska, to San Pedro, Calif.

Pterosiphonia bipinnata var. *robusta* (Gardner) Doty

Scagel, 1957
Sitka, Alaska, to Oreg.

Pterosiphonia californica Kylin

Kylin, 1941; Hollenberg, 1948
La Jolla, Calif.

Pterosiphonia dendroidea (Montagne) Falkenberg

Taylor, 1945; Scagel, 1957; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Northern British Columbia to San Jose del Cabo, Baja Calif.; Galapagos Arch.

Pterosiphonia gracilis Kylin

Scagel, 1957
Southern British Columbia to Coos Bay, Oreg.

Pterosiphonia pennata (Roth) Falkenberg

Dawson, 1954
Bahía Tepoca, Sonora

Levringiella gardneri (Setchell) Kylin

Dawson, 1945*c*; Hollenberg 1948 (both as *Stromatocarpus gardneri*); Kylin, 1956
Santa Monica to La Jolla, Calif.

Pterochondria pygmaea (Setchell) Hollenberg

Dawson, 1954; Dawson, Neushul & Wildman, 1960
Southern Calif. to Bahía Asunción, Baja Calif.

Pterochondria woodii (Harvey) Hollenberg

Scagel, 1957; Dawson, 1959*c*; Dawson, Neushul & Wildman, 1960
Vancouver, British Columbia, to Isla Asunción, Baja Calif.

Herposiphonia grandis Kylin

Scagel, 1957
Southern British Columbia to Coos Bay, Oreg.

Herposiphonia rigida Gardner var. *rigida*

Scagel, 1957
Southern British Columbia to Santa Monica, Calif.

Herposiphonia rigida var. *laxa* Setchell & Gardner

Dawson, 1949, 1954
Santa Catalina I., Calif.; Isla Guadalupe, Baja Calif.

Herposiphonia secunda (C. Agardh) Ambronn

Taylor, 1945; Hollenberg, 1948; Dawson, 1957, 1957*b*, 1959, 1959*b*, 1959*c*
Southern Calif. to Isla Jicarita, Panamá; southern Gulf of Calif.; Clipperton I.

Herposiphonia spinosa Dawson

Dawson, 1959
Isla Partida, Baja Calif. del Sur

Herposiphonia subdisticha Okamura

Dawson, 1954; Scagel, 1957 (both as *H. parva*); Dawson, 1954, 1957*b*, 1959, 1960*a*
Northern Wash. to Isla Guadalupe; Islas San Benito, Baja Calif.; Gulf of Calif.; Golfo de Nicoya, Costa Rica

Herposiphonia tenella (C. Agardh) Nägeli

Hollenberg, 1948; Dawson, 1954, 1954*c*, 1957*b*, 1959
Southern Calif. to Bahía Vizcaino, Baja Calif.; Kino, Sonora to Golfo de Nicoya, Costa Rica; Isla San Benedicto, Revillagigedo Arch.

Herposiphonia verticillata (Harvey) Kylin

Coe, 1932; Dawson, 1954, 1959*c*
San Francisco, Calif., to Punta Santa Rosalía, Baja Calif.

Amplisiphonia pacifica Hollenberg

Dawson, 1954; Scagel, 1957; Dawson, Neushul & Wildman, 1960, 1960*a*
Northern British Columbia to near Punta Eugenio, Baja Calif.

Jantinella verrucaeformis (Setchell & McFadden) Kylin

Dawson, 1954 (in part as *J. sinicola*), 1959; Setchell & Gardner, 1930 (as *J. sinicola*)
San Pedro, Calif., to Bahía Vizcaino, Baja Calif.; Isla Clarión, Revillagigedo Arch.; southern Gulf of Calif.

Chondria arcuata Hollenberg

Hollenberg, 1945
Corona del Mar; Laguna Beach, Calif.

Chondria californica (Collins) Kylin

Dawson, 1946 (as *C. cuscutoides*), 1954, 1954*d*, 1959, 1959*c*; Dawson, Neushul & Wildman, 1960
La Jolla, Calif., to Puerto Culebra, Costa Rica

Chondria clarionensis Setchell & Gardner

Dawson, 1954, 1959 (as possibly equal to *C. californica*)
Isla Guadalupe, Baja Calif., Isla Clarión, Revillagigedo Arch.

Chondria dangeardii Dawson

Dawson, 1960*a*
Isla del Rey, Panamá

Chondria dasyphylla (Woodward) C. Agardh

Dawson, 1954, 1959
Bahía Gonzaga to Bahía Agua Verde, Gulf of Calif.

Chondria decipiens Kylin

Smith, 1944; Dawson, 1945*b*, 1954, 1958, 1959, 1959*c*
Santa Cruz, Calif., to Cabo Colnett, Baja Calif. Isla San Pedro Nolasco, Gulf of Calif. ?

Chondria flexicaulis Taylor

Taylor, 1945
Galapagos Arch.

Chondria lancifolia Okamura

Dawson, 1957, 1957*b*
Rocas Alijos, Baja Calif.; Golfo de Nicoya, Costa Rica ?

Chondria nidifica Harvey

Kylin, 1941; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
La Jolla, Calif., to Bahía Asunción, Baja Calif.

Chondria oppositiclada Dawson

Dawson, 1946
La Jolla, Calif.

Chondria pacifica Setchell & Gardner

Dawson, 1954, 1958
Arroyo Hondo, Santa Barbara Co., Calif., to Bahía Tortuga, Baja Calif.

Chondria platyclada Taylor

Taylor, 1945 Dawson & Beaudette, 1960
Costa Rica; Isla Plata, Ecuador

Chondria repens Børgesen

Dawson, 1957*b*
Golfo Dulce, Costa Rica

Chondria secundata (J. Agardh) J. B. De Toni

J. B. De Toni, 1903
Santa Barbara, Calif.

Laurencia clarionensis Setchell & Gardner

Dawson, 1954
Isla Clarión, Revillagigedo Arch.

Laurencia congesta Taylor

Taylor, 1945
Galapagos Arch.

Laurencia crispa Hollenberg

Smith, 1944
Monterey Peninsula, Calif.

Laurencia decidua Dawson

Dawson, 1954*c*
Isla San Benedicto, Revillagigedo Arch.

Laurencia densissima Setchell & Gardner

Setchell & Gardner, 1937
Galapagos Arch.

Laurencia diegoensis Dawson

Hollenberg, 1948; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Carpinteria, Calif., to Punta Baja, Baja Calif.

Laurencia estebaniana Setchell & Gardner

Dawson, 1954
Isla Smith; Isla San Esteban, Gulf of Calif.

Laurencia gardneri Hollenberg

Smith, 1944
Monterey Peninsula, Calif.

Laurencia hancockii Dawson

Dawson, 1954
Bahía Agua Verde, Gulf of Calif.

Laurencia humilis Setchell & Gardner

Dawson, 1954
Isla Clarión, Revillagigedo Arch.

Laurencia intricata Lamouroux

Dawson, 1954
Bahía Petatlán, Guerrero

Laurencia johnstonii Setchell & Gardner

Dawson, 1954
Northern Gulf of Calif.

Laurencia lajolla Dawson

Dawson, 1958
La Jolla, Calif.

Laurencia masonii Setchell & Gardner

Dawson, 1954
Isla Guadalupe, Baja Calif.

Laurencia mediocris Setchell & Gardner

Setchell & Gardner, 1937
Galapagos Arch.

Laurencia multibulba Dawson, Neushul & Wildman

Dawson, Neushul & Wildman, 1960*a*
Off Punta Hughes and Punta Entrada, Isla Magdalena, Baja Calif.

Laurencia obtusa (Hudson) Lamouroux var. *gracilis* Harvey

Taylor, 1945
Galapagos Arch.

Laurencia obtusiuscula Setchell & Gardner var. *obtusiuscula*

Dawson, 1949*a*, 1954, 1959; Dawson, Neushul & Wildman, 1960*a*
Near Punta Eugenio, Baja Calif.; Gulf of Calif. from Guaymas to San Jose del Cabo

Laurencia obtusiuscula var. *corymbifera* Setchell & Gardner, prox.

Taylor, 1945
Galapagos Arch.

Laurencia obtusiuscula var. *laxa* Setchell & Gardner

Dawson, 1959, 1954 (as *L. obtusiuscula*)
Southern Gulf of Calif.

Laurencia oppositoclada Taylor

Taylor, 1945
Galapagos Arch.

Laurencia pacifica Kylin

Smith, 1944; Dawson, 1954, 1959*c*
Pacific Grove, Calif., to Isla Magdalena, Baja Calif.

Laurencia paniculata (C. Agardh) J. Agardh

Dawson, 1954
Bahía Gonzaga; Guaymas to Bahía Agua Verde, Gulf of Calif.

Laurencia papillosa var. *pacifica* Setchell & Gardner

Dawson, 1954, 1959
Isla Guadalupe; southern Gulf of Calif.

Laurencia peninsularis Taylor

Dawson, 1954
Cabo San Lazaro, Baja Calif.

Laurencia richardsii Dawson

Dawson, 1954*c*
Isla San Benedicto, Revillagigedo Arch.

Laurencia scrippsensis Dawson

Dawson, 1954, 1954*c*
La Jolla, Calif., to Isla Magdalena, Baja Calif.; Isla San Benedicto, Revillagigedo Arch.

Laurencia sinicola Setchell & Gardner

Dawson, 1954, 1959
Southern Gulf of Calif.

Laurencia synderae Dawson

Dawson, 1954, 1954*a*
Santa Catalina I.; La Jolla, Calif.; Islas San Benito; Scammon Lagoon; Bahía Vizcaino, Baja Calif.

Laurencia spectabilis Postels & Ruprecht

Scagel, 1957; Dawson, 1959*c*
Sitka, Alaska, to nothern Santa Barbara Co., Calif.

Laurencia splendens Hollenberg

Smith, 1944; Dawson, 1954, 1959*c*; Dawson, Neushul & Wildman, 1960
Santa Cruz, Calif., to Punta Baja, Baja Calif.

Laurencia subdisticha Dawson, Neushul & Wildman

Dawson, Neushul & Wildman, 1960*a*
Islas San Benito, Baja Calif.; Isla Jicarón, Panamá

Laurencia subopposita (J. Agardh) Setchell

Dawson, 1944*a*, 1954; Dawson, Neushul & Wildman, 1960, 1960*a*
La Jolla, Calif., to Punta Eugenio, Baja Calif.

Laurencia turbinata Setchell & Gardner

Setchell & Gardner, 1937
Isla San Martín, Baja Calif.; Galapagos Arch.

Laurencia voragina Taylor

Dawson, 1954
White Friars I., Guerrero

Erythrocystis saccata (J. Agardh) Silva

Smith, 1944 (as *Ricardia saccata*); Silva, 1952; Dawson, 1954, 1954*c*
Pacific Grove, Calif., to Isla Guadalupe, Baja Calif.; Isla San Benedicto, Revillagigedo Arch.

Janczewskia gardneri Setchell & Gardner

Dawson, 1954; Scagel, 1957
Vancouver I., British Columbia, to Cabo Colnett, Baja Calif.

Janczewskia lappacea Setchell

Kylin, 1941; Dawson, 1954
San Pedro, Calif., to Cabo Colnett, Baja Calif.

Janczewskia moriformis Setchell

Setchell, 1914
Santa Monica, Calif.

Janczewskia solmsii Setchell & Guernsey

Dawson, 1954*b*, 1954
Redondo to San Diego, Calif.; Isla Guadalupe, Baja Calif.

Rhodomela larix (Turner) C. Agardh

Okamura, 1933; Scagel, 1957; Dawson, 1958, 1959*c*
Bering Sea to Government Point, Calif.

Rhodomela lycopodioides (Linnaeus) C. Agardh

Okamura, 1933; Scagel, 1957
Aleutian I., Alaska, to northern Wash.

Rhodomela macrantha (Kützing) Setchell

Tokida, 1949
Alaska; British Columbia

Odonthalia aleutica (Mertens) J. Agardh

Okamura, 1933
Aleutian I., Alaska

Odonthalia dentata (Linnaeus) Lyngbye

Setchell & Gardner, 1903; Tokida, 1949
Alaska to Victoria, British Columbia

Odonthalia floccosa (Esper) Falkenberg

Scagel, 1957
Southern British Columbia to Pismo Beach, Calif.

Odonthalia kamtschatica (Ruprecht) J. Agardh

Scagel, 1957
Alaska to Puget Sound, Wash.

Odonthalia lyallii (Harvey) J. Agardh

Okamura, 1933; Scagel, 1957
Alaska to northern Wash.; Oreg. ?

Odonthalia oregana Doty

Doty, 1947
Curry Co., Oreg.

Odonthalia washingtoniensis Kylin

Scagel, 1957
Hope I., British Columbia, to Coos Bay, Oreg.

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Fishes Killed by the 1950 Eruption of Mauna Loa, Part V
Gonostomatidae

MARION GREY[1]

AMONG THE DEEP-SEA FISHES collected at the surface during the Mauna Loa lava flow into the sea in 1950 were 30 small specimens belonging to the family Gonostomatidae. Of the 5 genera and 5 species represented, 2 of the genera (1 of them new) and all of the species (1 or 2 of them new) were hitherto unknown from waters around the Hawaiian Islands. Gosline *et al.* (1954) described the lava flow and the methods of collecting. I am indebted to Dr. Gosline for permission to report on these specimens, and to Dr. Rolf Bolin for relinquishing his prior claim to them.

Gonostoma atlanticum Norman

MATERIAL EXAMINED: 1 specimen, 59.5 mm. in standard length, collected off the Mauna Loa lava flow, Hawaii, by Moore *et al.*, June 3, 1950.

One specimen, 47 mm. in standard length, collected off the Mauna Loa lava flow, Hawaii, by Yamaguchi, June 6, 1950.

Three specimens, 58.5, 54, and 49 mm. in standard length, collected off the Mauna Loa lava flow, Hawaii, by Gosline *et al.*, June 6, 1950.

Counts and measurements given in order of diminishing size, largest specimen first. Dorsal rays 17, 17, 18, 18, 16. Anal rays 28, 29, 29, 28, 28. Pectoral rays 10. Ventral rays 6. Gill rakers on first arch 11 + 6, 11 + 6, ? + 6, —, 11 + 7. Photophores: BR 9; IV 16; VAV 5; AC 19 (partially lost in smallest specimen); IC 40; OA 13.

Per cent of standard length (59.5, 58.5, 54, 49, 47 mm.): depth 16.8, 17.1–17.9, 16.7–17.6, *ca.* 18.3, 18.0; head 24.3, 25.6, 25.0, 24.5–25.5, 25.5; snout 4.2, 4.27–5.12, 4.62, —, 4.25–5.3; orbit 4.2, 4.27, 3.5–4.62, —, 4.25; interorbital width at center of eye 3.36, 3.42–4.27, 3.5–4.62, —, *ca.* 4.25; upper jaw 18.5, 19.6–20.4, 20.4, 19.4–20.4, 20.2–21.2; premaxillary 3.36, 4.27–5.1, 4.62, —, 5.3; toothed portion of maxillary 14.3, 15.4, 15.7, —, 15.9; tip of snout to dorsal origin 58.0, 58.9, 58.4–59.2, 58.1–59.1, 59.5; to anal origin 56.3, 57.2, 56.5–57.4, 56.1, 56.4; to ventral bases 46.2, 48.6, 46.2, 47.8, 46.7; distance between anal origin and caudal base 41.1–42.0, 42.7, 41.6, 42.7, 42.5; between last anal ray and caudal base *ca.* 10.1, *ca.* 10.2, 10.2, —, 10.6; between last dorsal ray and caudal base *ca.* 23.5, *ca.* 22.2, 22.2–23.1, —, *ca.* 23.4; between inner insertion of ventral and origin of anal *ca.* 8.4, 9.4, 7.4–8.3, —, *ca.* 7.45; least depth of caudal peduncle 5.8–6.7, 5.97–6.83, *ca.* 5.5, —, 6.38; dorsal base 16.8, *ca.* 17.1, 17.6, —, *ca.* 17.0; anal base 31.9, 32.4, 33.3, —, *ca.* 32.0; pectoral length —, 17.1, 16.7, —, 12.75; ventral length *ca.* 7.56, 6.83, 7.4, —, 6.38.

Skin partially lost in all specimens. Only a few scales remaining, mostly over photophores, but well-preserved scale pockets indicating that back and tail, at least, were fully clothed with large, thin, cycloid scales. Pectoral fins reaching as far as 12th or 13th IV photophore. Ventral fins reaching anus. Most specimens with 13 long teeth on maxillary (only 9 or 10 in 2 specimens reported by me in 1960 from the Marshall Islands) and apparently no posterior pterygoid teeth. Three largest specimens with 3 palatine teeth, increasing in size posteriorly. A small reflector present behind ORB in only 1 specimen (47 mm.). Only two largest with small glands visible below OA. All 5 specimens with a single pale yellowish infracaudal gland at base of posterior procumbent caudal rays; possibly a second one originally existed anterior to it. Two well-developed supracaudals with the outward appearance of large photophores, being surrounded on sides and lower surface by blackish brown pigment.

Color blackish brown, head and abdomen darker, cheeks silvery or iridescent and with black puncticulations, peritoneum black, oper-

[1] Chicago Natural History Museum, Chicago, Illinois. Manuscript received December 19, 1960.

cular linings brown, inside of mouth pale anteriorly and brown posteriorly.

Largest specimen (abdomen damaged), a female with large ovaries.

Counts and measurements are in close agreement with those found in published descriptions of this species. The body depth is possibly somewhat greater in Hawaiian specimens and the count, in one, of 11 + 7 gill rakers is unique.

These specimens represent the second Pacific record of *G. atlanticum*. The first capture was in the Marshall Islands area (Grey, 1960). The species is probably more widely distributed in the central portions of the Pacific Ocean than is known at present.

Cyclothone sp.

MATERIAL EXAMINED: 3 specimens, standard length *ca.* 20.5, *ca.* 23, and *ca.* 23.5 mm., collected off the Mauna Loa lava flow, Hawaii, by Moore *et al.*, June 3, 1950.

Specimens all in poor condition; following characters common to all: first VAV very close to ventral base, anus directly below it; VAV evenly spaced; color pale brownish, abdomen darker, myomeres outlined in darker pigment; on 1 specimen a shred of skin with a few black spots remaining, its original position on body not determinable; 2 narrow vertical brown bars at extreme end of caudal peduncle, 1 above mid-line and 1 below mid-line; dashes of internal pigment at end of caudal peduncle; a series of 6 internal brown spots along base of dorsal fin and 18 along anal base; ventral portion of body between ventral and anal fins, below musculature, entirely colorless and transparent, the VAV photophores situated in this region; branchiostegal membrane with a narrow brown line at base and a broken line of brown pigment on edge, otherwise colorless; a bar of brown pigment curving down from pectoral base and extending forward on isthmus.

Specimen *ca.* 23.5 mm.: BR 8; VAV 4, possibly only 3 (fourth at first anal ray). IV, AC, and OA all lost or damaged. Maxillary teeth subequal, becoming gradually larger posteriorly, first one not larger than those immediately behind it.

Specimen *ca.* 23 mm.: BR 8, IV 13. VAV 4, possibly only 3 (fourth at first anal ray). AC and OA mostly lost. Dorsal rays probably 12, anal rays probably 19.

Specimen *ca.* 20.5 mm.: BR 7. IV and VAV mostly lost. AC 9 or 10, last one on caudal base. Last two VAV present, last at anal origin; if this photophore belongs to the AC series, the total number is 10. Gill rakers on first arch 9 + 1 + 3 = 13, only 1 in angle. Vomer toothless. Palatines and pterygoids each with 3 microscopic teeth. Ventral fins undamaged, reaching to or slightly past anal origin.

Both the poor condition of the Hawaiian specimens and the uncertain taxonomic status of species of the genus *Cyclothone* Goode and Bean prevent positive identification of these specimens. They are allied to *C. signata* Garman and *C. alba* Brauer (pale coloration, a single gill raker in the angle of the first arch, no vomerine teeth) and are possibly identical with *C. alba*. However, *C. alba* was described with an AC count of 12 or 13, similar to that of *C. signata*, and the AC number is only 9 or 10 on the only Hawaiian specimen on which these photophores are preserved. The total number of gill rakers on the first arch is similar in all 3 forms, 13 in the 1 Hawaiian specimen on which they can be counted, 14–15 in *C. signata* and *C. alba*. *C. alba* and the Hawaiian specimens have 7–8 BR photophores, in contrast to the 9 or 10 of *C. signata*. Both the first VAV photophore and the anus of the Hawaiian specimens are extremely close to the ventral bases. In *C. alba* these were figured by Brauer (1906: 80, fig. 30) as being placed somewhat more posteriorly. However, in specimens examined from the Atlantic (Florida), probably identical with *C. alba*, the first VAV is also closer to the ventral bases than shown in Brauer's figure and this character may be a variable one.

Although it is no surprise to learn that a light-colored *Cyclothone* inhabits Hawaiian waters, the only species of the genus hitherto reported from the area have been the dark-colored forms *C. atraria* Gilbert and *C. canina* Gilbert.

Araiophos, NEW GENUS

TYPE SPECIES: *Araiophos gracilis*, new species.

Eye normal, large. Snout shorter than orbit. Interorbital width at center of eye less than diameter of orbit or length of snout. Mouth

FIG. 1. *Araiophos gracilis*, holotype, standard length 34 mm.

moderate, oblique; edge of premaxillary straight, its angle oblique; toothed edge of maxillary slightly convex, reaching beyond middle of eye but not as far as its posterior margin. Premaxillary about half as long as toothed portion of maxillary. Angle of preopercle almost vertical. All teeth minute, not numerous, uniserial in upper jaw; lower jaw with an outer row of 3–4 teeth anteriorly. Presence or absence of teeth on vomer, palatines, pterygoids, and tongue not determinable. Gill rakers on first arch $15 + 3 = 18$ (1 specimen), 2 in angle. Minute (microscopic) clusters of spines on inner edge of first gill arch. Presence or absence of pseudobranchiae not determinable. No evidence of scales. Anus about half-way between ventral bases and anal origin or slightly nearer the former. Head and trunk about equal in length to tail or slightly shorter. Origin of dorsal fin well behind middle of body length. Anal origin and ventral bases well ahead of dorsal origin. Adipose fin present. ORB 1, in front of eye, close to premaxillary. OP 1 (lower posterior), level with end of maxillary. SO absent. BR (6). No additional photophores on head. Body with a single row of photophores; photophores present on isthmus. IV (2) on isthmus, $+ (3) + 4 + (2) = 11$. VAV (4–5). AC (2) + 3–4 + (2) = 7–8. IC 22–23. No additional photophores and no luminous tissue on body as far as known. Fin rays: dorsal 13–14, anal 28–29, pectoral (15?) 16–17, ventral 6. Branchiostegal rays 8, no spines at bases. Number of vertebrae unknown.

Araiophos differs distinctly from all other maurolicid genera in the reduced number of photophores. Only in the BR count of 6 and the VAV count of 4 or 5 is it similar to others (*Valenciennellus* Jordan and Evermann also has 4 or 5 VAV and several genera have 5). The small number of photophores might be a juvenile character and the absence of photophores between the isthmus and the posterior end of the pectoral base (where in some species they are known to develop late), the absence of 2 of the OP, and the small size of the ORB, give support to the possibility that all of the specimens studied are young. On the other hand, although the specimens range in standard length from a little over 21 mm. to 34 mm., the number and relative size of the photophores are identical in all. If more were to develop, on the body at least, one would expect to find the smallest specimen differing somewhat from the largest. The presence of gonads is also significant and the obvious implication is that *Araiophos* provides another example of neoteny among fishes. Even were the specimens still juvenile they could not be shown to belong to any known genus. Only in *Maurolicus* Cocco is the dorsal fin situated so far behind the middle of the body length; and the Hawaiian specimens cannot belong to *Maurolicus*, in which the developmental stages are well known and which has acquired all of the meristic characters of the adult at a length of about 20 mm. Nor is it likely that the Hawaiian specimens represent a metamorphosis stage of some known genus; as far as we know the development of maurolicid genera is direct and none are known to undergo a metamorphosis

stage with changes in body form or fin positions.

An attempt to modify the diagnosis of one of the known genera to accept this new form has been unsuccessful. Several characters align it with *Thorophos* Bruun and *Neophos* Myers: relative positions of dorsal and anal origins; number of gill rakers; elongate body form; IV photophores on isthmus straight, none curving upward toward pectoral base; VAV not reaching anal origin. The lack of OA photophores, if not a juvenile character, is an additional point of resemblance between the new genus and *Neophos*, which has only 1 OA. However, in both *Thorophos* and *Neophos* the angle of the gape anteriorly is much more acute than that of *Araiophos*, and in *Neophos* and *Thorophos* the gape is wider, the maxillary reaching to or beyond the posterior margin of the eye (only slightly past the middle of the eye in *Araiophos*). In fin ray counts *Araiophos* is closest to *Argyripnus* Gilbert and Cramer, and to *Maurolicus;* and only in the latter, among maurolicid genera, is the dorsal origin situated well behind the middle of the body length as it is in *Araiophos*.

Derivation of name: *araios*, Gr., 'few'; *phos*, Gr., 'light.'

***Araiophos gracilis*, new species**
Figs. 1–3

HOLOTYPE: Standard length 34 mm., collected off the Mauna Loa lava flow, Hawaii, by Gosline *et al.*, June 6, 1950.

PARATYPES: 9 specimens, standard length 30.5, 24, and 23 mm. (3 specimens); length from tip of snout to base of caudal fin 31.5, 28, 27.5, and 26.5 mm. (5 specimens, lower jaws broken), and *ca.* 21 mm. from nape to base of caudal fin (1 specimen, head lacking), collected off the Mauna Loa lava flow, Hawaii, by Moore *et al.*, June 3, 1950.

Dorsal rays 13–14 (holotype 14). Anal rays 28–29 (holotype 29). Pectoral rays 16–17 (holotype 16, possibly only 15). Ventral rays 6. Branchiostegal rays 8. Gill rakers on first arch 15 + 3 = 18 (holotype only), 2 in angle.

Measurements of holotype expressed in per cent of the standard length (34 mm.), followed in parentheses by similar measurements of 2 specimens 31.5 mm. from tip of snout to caudal base and 30.5 mm. in standard length: depth 13.2 (12.7, 13.1–14.7); head *ca.* 22.1 (—, 22.9); snout 5.87 (—, 6.55); orbit 8.8

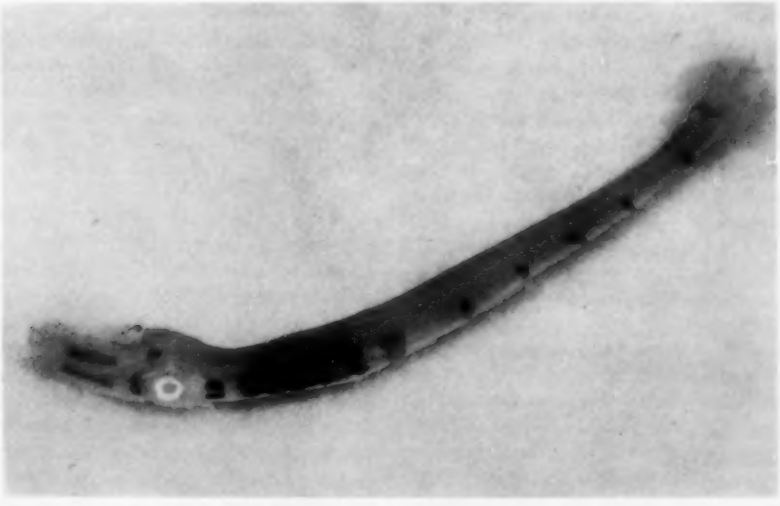

FIG. 2. *Araiophos gracilis*, holotype, ventral view.

FIG. 3. *Araiophos gracilis*, paratypes, standard length 30.5 and *ca.* 23 mm.

(7.87, 6.55–8.19); interorbital width at center of eye 4.41 (4.73, *ca.* 4.9); upper jaw 13.2; premaxillary *ca.* 4.41; toothed portion of maxillary 8.8; distance between tip of snout and dorsal origin 57.3 (55.2, 57.3), anal origin 48.5 (46.6–47.3, *ca.* 49.0, and in a specimen 28 mm. long from snout to caudal 48.2–50.0), ventral base *ca.* 44.1 (*ca.* 39.4, 44.1); distance between first anal ray and base of middle caudal rays 51.4 (52.0, 49.0, and in a specimen 28 mm. long from snout to caudal 50.0), last anal ray and base of middle caudal rays *ca.* 11.7 (11.0, 14.7–16.4), last dorsal ray and base of middle caudal rays 27.9 (*ca.* 28.4, *ca.* 26.2), last dorsal ray and adipose fin 4.41 (6.3, —), ventral bases and anal origin 5.87 (4.73, 4.9); least depth of caudal peduncle 5.87 (6.3, 4.9–6.55); dorsal base 11.7 (14.2?, 11.5–13.1); anal base 38.2 (39.4, 31.1–32.8); adipose base 2.94 (6.3, —, and in a specimen 23 mm. in standard length 4.34–6.52).

Specimens all damaged to some extent, especially in head and abdominal regions; both eyes of holotype lost, this specimen otherwise in fair condition.

Body elongate, slender, compressed but with ventral surface flat between the second single abdominal IV photophore and the VAV group. No scales or scale pockets remaining. Pectoral fins of holotype reaching half-way between pectoral and ventral bases; bases broadly pedunculate. Ventral fins of holotype reaching anal origin. Adipose fin with a relatively long base; very fragile and easily lost, leaving no trace (absent on 2 specimens, tearing loose on a third, possibly incomplete on holotype); its origin above a vertical from the third single AC photophore, above end of anal fin.

Specimens too small and fragile to determine presence or absence of pseudobranchiae.

Teeth rather sparse, visible only under magnification, their presence or absence on vomer, palatines, pterygoids, or tongue impossible to determine but 1 specimen with a few minute teeth on roof of mouth anteriorly.

Photophores as in generic diagnosis. ORB minute, close to premaxillary. The single OP double, relatively large. Only (2) small IV on isthmus posteriorly, well separated from abdominal IV (no photophores between isthmus and posterior end of pectoral base); abdominal IV commencing just behind pectoral base, organs of groups (first 3 and last 2 organs) small, the 4 single organs much larger, well separated from one another. VAV occupying only anterior half of space between ventrals and anal, the individual organs very small; anus below last, thus about half-way between ventral bases and anal

origin or slightly nearer the former; number usually (4), two specimens with (4) on one side and (5) on the other, holotype with (4) on both sides. First group of AC (two organs) above fifth to seventh anal rays, last group (two organs) behind anal fin but remote from caudal base; single organs much larger than individual organs of groups; number of single organs usually 3, 3 specimens with 3 on one side and 4 on the other, holotype with 3 on both sides.

Visible inside flattened belly of most specimens are two long, narrow, whitish or yellowish masses with the appearance of testes, extending forward to third or fourth single IV photophore. In addition to these structures at least 4 specimens (24, 27.5, 27.5, 31.5 mm.) also with ovaries; eggs minute except in 24 mm. specimen, in which the ovaries are relatively large and contain eggs of different sizes.

Color in alcohol yellowish, abdomen darker. Minute brown puncticulations along mid-line on tail, and outlining myomeres of tail. A narrow vertical brown bar at extreme end of caudal peduncle. Some specimens with a short series of minute brown spots along anal base between first AC group and second single AC. Sparse brown pigment on top of head. A few minute brown spots on caudal rays, fins otherwise colorless. Inner bronzy iridescence and a few relatively large black chromatophores visible through abdominal wall laterally.

Danaphos oculatus (Garman)

MATERIAL EXAMINED: 7 specimens, 2 31.5 and *ca.* 39 mm. in standard length, others slightly shorter but too damaged to measure, collected off the Mauna Loa lava flow, Hawaii, by Moore *et al.*, June 3, 1950.

Two specimens, standard length 36.5 and *ca.* 36.5 mm., collected off the Mauna Loa lava flow, Hawaii, by Gosline *et al.*, June 6, 1950.

One specimen, standard length 33 mm., collected off the Mauna Loa lava flow, Hawaii, by Yamaguchi, June 6, 1950.

Dorsal rays 6 (4 specimens). Anal rays (23?) 24–25 (6 specimens). Pectoral rays *ca.* 18 and *ca.* 16 (2 specimens), upper 7 or 8 rays longer and much heavier than others, lowermost rays small and fine. Gill rakers on first arch 10–11 + 1 + 2 = 13–14 (2 specimens), only 1 in angle.

Measurements of 2 specimens expressed in per cent of the standard length (36.5 and 33 mm.): depth 23.3, 21.2; head 23.3–24.6, 24.2; snout 5.47, 4.54; orbit (both vertical and horizontal) 8.2, 7.55; interorbital width too narrow to be measured accurately; upper jaw —, 15.1–16.6; premaxillary 8.2–9.6, 7.55; toothed portion of maxillary 9.6–10.95, 9.06; tip of snout to dorsal origin 34.2, 34.8; to anal origin 46.5, 45.4–46.9; to ventral base *ca.* 41.0, 37.8–39.3; distance between first anal ray and base of middle caudal rays 52.0, 56.0–57.5; between last anal ray and base of middle caudal rays 8.2–9.6, 7.55; between last dorsal ray and middle caudal rays *ca.* 60.2, 53.0; least depth of caudal peduncle *ca.* 6.85, 7.55; dorsal base *ca.* 4.1, *ca.* 4.54; anal base *ca.* 43.8, 46.9; length of pectoral fin 24.6, 24.2–25.7; length of ventral fin 8.2–9.6, 9.06–10.6.

A few large, round, thin scales remaining on several specimens. Anus below third VAV, slightly nearer anal fin than ventral bases. Dorsal base very short. Anal origin close behind a vertical from last dorsal ray. No adipose fin. Pectorals, when complete, extending as far as third VAV photophore. Ventrals, when complete, reaching slightly past anal origin. Ventral bases below dorsal fin.

Photophores: No upper OP. BR (6). IV complete on only 2 specimens; (3) + (4) on isthmus, organs of first group smaller than those of second group; abdominal group 11, in 1 specimen the first one separate, connection of others not determinable; abdominal series of a second specimen separated thus: 1 + (2) + (8), the gland joining the (2) obvious on outer surface of body, the (8) seen through damaged abdomen to be joined to one another by a narrow gland, and each organ also joined to its counterpart on other side of body; total IV 17–18. VAV (5) in all 10 specimens. AC (3) + 15 + (4) + 1 = 23 in 5 specimens, (4) + 15 + (4) + 1 = 24 in 1 specimen, (3) + 14 + (4) + 1 = 22 in 1 specimen, (3) + 16 + (4) + 1 = 24 in 1 specimen, and 1 specimen with (3) + 16 + (4) + 1 = 24 on one side, (3) + 17 + (4) + 1 = 25 on other side; damaged in 1 specimen. OA (2) + 4 = 6, complete on only 1 specimen.

In alcohol, color of tail and back whitish, abdomen and head, excepting the colorless snout, blackish. Body wall along most of anal base colorless and transparent. End of caudal peduncle blackish. A series of about 28 black spots running from nape almost to caudal base.

Two specimens contain ovaries, the eggs larger in one than in the other.

D. oculatus has not been reported previously from the Hawaiian Islands although it is known to inhabit adjacent parts of the North Pacific, as well as the eastern Pacific from off Lower California to Monterey Bay.

Argyripnus atlanticus Maul
Figs. 4, 5

MATERIAL EXAMINED: 2 specimens, standard length 27 or 27.5 mm. and 35.5 mm., collected off the Mauna Loa lava flow, Hawaii, by Moore *et al.*, June 3, 1950.

Smaller specimen in poor condition; head, tail, and abdomen severely damaged; adipose fin, latter part of anal fin, last group of AC photophores, and isthmus IV mostly lost; abdominal IV damaged. Dorsal rays 12. Anal rays *ca.* 12 in front of AC group of five photophores. Pectoral fins short and fleshy, rays discernible under magnification but not clearly enough to be counted. Gill rakers on first arch 19 + 5 = 24 on left side, 19 + 6 = 25 on right side, 2 in angle. Depth 5–5.5 mm. Head and trunk shorter than tail, distance between snout and anal origin *ca.* 12–12.5 mm. and between first anal ray and base of middle caudal rays 15 mm. Anal origin below about fourth dorsal ray. BR (6). IV on isthmus (6) on one side, apparently straight, not curving upward posteriorly; abdominal IV (10), hanging loose from body, possibly incomplete. First VAV-AC group (14), probably not fully developed, first 6 or 7 in front of anal fin and larger than remainder. Middle group of AC (5). OA lost on one side of body, (2) on other side, remainder probably still undeveloped. Color in alcohol yellowish; upper half of body with a double series of small black chromatophores from nape to tail and a third, incomplete, row running posteriorly from above anal origin.

Larger specimen, 35.5 mm., in fairly good condition although difficult to measure, being bent. A few large, thin, cycloid scales remaining on back and sides. Dorsal rays 11. Anal rays 15 + 10 = 25, a short space filled with membrane below third and fourth organs of the AC group of (5), separating the two groups of rays. Pectoral rays 18. Gill rakers on first arch 19 + 6 = 25, 2 in angle.

Measurements in millimeters: depth 8; head 11; snout 2–2.5; orbit *ca.* 4; interorbital width at center of eye 2–2.5; upper jaw 7–7.5; premaxillary 3–3.5; toothed portion of maxillary 4–4.5; tip of snout to dorsal origin *ca.* 17, to anal origin 15.5, to ventral base *ca.* 12.5–13; distance between first anal ray and base of middle caudal rays 18.5–19, last anal ray and base of middle caudal rays *ca.* 6.5, last dorsal ray and base of middle caudal rays *ca.* 15; least depth of caudal peduncle 2.5–3; dorsal base 3.5–4; anal base *ca.* 11.5; pectoral length 6.5–7; adipose base 1.5; distance between VAV-AC group of photophores and group of (5) 3.5

FIG. 4. *Argyripnus atlanticus*, standard length 35.5 mm.

FIG. 5. *Argyripnus atlanticus*, standard length 35.5 mm., ventral view.

and between group of (5) and posterior AC group 3.5–4.

Premaxillary more than half as long as toothed portion of maxillary. Maxillary reaching a vertical from posterior margin of eye. Head and trunk shorter than tail. Anal origin slightly in advance of dorsal origin, which is above a vertical from about third anal ray. Adipose fin well developed, its origin above a vertical from just behind AC group of (5). Pectoral fin long, nearly reaching anal origin. Ventrals inserted well in advance of dorsal origin, ends of rays broken.

BR (6). IV (6) + (11) = 17, first organ of abdominal group directly below last organ of isthmus group, which curves upward posteriorly; individual organs of first group slightly larger than those of abdominal group. VAV-AC (21) + (5) + (17) = 43, first 7 in front of anal fin and larger than remainder, upward curve over anal fin low and gradual. IC 60. OA (2) + 3 = 5 on left side, no damage apparent, probably not fully developed; ? + 4 on right side, first organs lost but gland remaining (possibly contained 2–3 photophores).

Color in alcohol yellowish; diffuse brown pigment on caudal peduncle and nape; 3 irregular series of small black chromatophores from nape to caudal.

These two little fishes are considerbly smaller than any specimens of the genus *Argyripnus* previously reported and provide the first scant evidence of developmental changes. The larger one possibly possesses all adult characters but it seems more likely that the OA are still incomplete and that a few of the organs of the first VAV-AC group have not yet developed. One or 2 additional organs may also appear in the last group of AC, which in this little fish begins directly behind the anal fin. In all other specimens of *Argyripnus* seen or figured there are 2 to 4 of these photophores above the end of the anal fin.

Characters of the smaller specimen suggest that the middle group of 5 AC develops relatively early and that of the anterior VAV-AC group the organs in front of the anal fin appear first. In the last group of AC the posterior organs are apparently first to appear. The OA develop late, probably being still incomplete on the 35.5 mm. specimen. If the isthmus IV are actually straight on the small damaged fish, as they appear to be, the displacement upward of the posterior organs would occur after the species reaches a

standard length of about 27 mm. and before it attains 35 mm. An additional juvenile character of the smaller specimen is the short, fleshy pectoral fin.

The larger of the 2 Hawaiian specimens differs from all others of the genus *Argyripnus* in two rather important characters, the position of the anal origin in front of the dorsal origin, and the abdominal count of 11 IV. The IV photophores number (6) + (10) = 16 in almost all known specimens of the genus, the only exceptions being found on 2 western Atlantic specimens in which the counts are (6/7) + (10) = 16/17 and (6) + (9/10) = 15/16. Both of the Hawaiian specimens are otherwise very close to, and probably identical with, *A. atlanticus* Maul, a species hitherto known only from the North Atlantic. In Pacific species (*A. ephippiatus* Gilbert and Cramer, *A. iridescens* McCulloch, and an unrecorded specimen from the Philippines) the anal origin is situated below the end of the dorsal fin. In *A. atlanticus* it is below the anterior rays of the dorsal and the anal origin of the younger Hawaiian specimen is similar. The fact that the two little Hawaiian fishes differ from one another in this character suggests that the anal position may be somewhat variable. In meristic characters these specimens differ from *A. atlanticus* only in the number of photophores in the first VAV-AC group and, as noted above, these photophores are probably not fully developed on the Hawaiian fishes. If a few more photophores are still to appear in this series, both the VAV-AC and the IC counts would be within the range of the same counts of *A. atlanticus*. Evidence that a few more photophores actually are present in the adult is shown by the fact that the distance between the AC groups is proportionately greater than in any other specimens of the genus known (see Table 3).

These specimens are also like *A. atlanticus* and unlike other species in the lower and less abrupt curve in the VAV-AC series above the front of the anal fin. Their more slender bodies can certainly be attributed to their youth and the relative lengths of the trunk and tail probably also change with age. Both of the young Hawaiian fishes have a proportionately longer tail, shorter trunk, and shorter distance between the snout and ventral bases than are found in older specimens from either the Atlantic or Pacific oceans.

TABLE 1

MERISTIC CHARACTERS OF *Argyripnus* SPECIES

SPECIMENS	STANDARD LENGTH	DORSAL RAYS	ANAL RAYS	PECTORAL RAYS	VENTRAL RAYS	GILL RAKERS ON FIRST ARCH
A. atlanticus, juv. Hawaii	27–27.5	11–12	—	—	—	19+5–6=24–25
A. atlanticus, juv. Hawaii	35.5	11	15+10=25	18	—	19+6=25
A. atlanticus, type[1] eastern Atlantic	56	12	—=27	19	7	17+7=24
A. atlanticus western Atlantic	55–71	11–12	13–15+(8)9–10=22–27	(16)17–19	6–7	17–19+6–7=22–26
A. ephippiatus Hawaii	72	12	12+12=24	15	6?	13–14+5=18–19
A. ephippiatus, type Hawaii	75	11	11+11=22	15	—	14+5=19
A. ephippiatus Hawaii	80	11–12	—	15	—	13+5–6=18–19
A. iridescens[2] Australia	90–135	12–14	—=24–25	16–17	7	16+?=?
Argyripnus sp. Philippines	82	12	13+12=25	17	7	12+4=16

[1] Data from Maul, 1952: 56.
[2] From McCulloch, 1926: 169, and Norman, 1930: 299.

TABLE 2

PHOTOPHORE COUNTS OF *Argyripnus* SPECIES

SPECIMENS	STANDARD LENGTH	IV	VAV+ FIRST GROUP OF AC	POSTERIOR AC GROUP	VAV[4] +AC TOTAL	IC	OA
A. atlanticus, juv. Hawaii	27–27.5	—	(14)	—	—	—	(2)
A. atlanticus, juv. Hawaii	35.5	(6)+(11)=17	(21)	(17)	43	60	(2)+3=5
A. atlanticus, type[1] eastern Atlantic	56	(6)+(10)=16	(28)	(18)	51	67	7
A. atlanticus western Atlantic	55–71	(6/7)+(9/10)= 15–17[2]	(24–28)	(16–18)	46–51	62–67	(3–4)+3–4=7
A. ephippiatus Hawaii	72	(6)+(10)=16	(20)	(14)	39	55	(5)+2=7
A. ephippiatus, type Hawaii	75	(6)+(10)=16	(19)	(14/15)	38/39	55/56	(5)+2=7
A. ephippiatus Hawaii	80	—	—	—	—	—	(5)+2=7
A. iridescens[3] Australia	90–135	(6)+(10)=16	(20–21)	(12–14)	37–40	53–56	7
Argyripnus sp. Philippines	82	(6)+(10)=16	(18)	(12)	35	51	(5/6)+(1/2)= 7

[1] From Maul, 1952: 56.
[2] See footnote to Table 1.
[3] IV usually (6)+(10)=16; 7 in isthmus group on one side of 1 specimen only and 9 in abdominal group on one side only of a second specimen.
[4] Including middle AC group, which is always (5).

SPECIES OF *Argyripnus*

Meristic characters and some body proportions of a number of specimens of *Argyripnus* are shown in Tables 1–3. In addition to the young specimens reported here the following have been examined: *A. ephippiatus* Gilbert and Cramer, holotype, USNM no. 47708, "Albatross" sta. 3472; and two specimens, USNM no. 126079, Hawaii, "Albatross," 1902, exact data lacking (probably the specimens reported in 1905 by Gilbert). *Argyripnus* sp., USNM no. 135402, Philippines, "Albatross" sta. 5542, vicinity of northern Mindanao, 8° 48′ 30″ N., 123° 35′ 30″ E., 200 fathoms (366 m.), 1 specimen, hitherto unreported. *A. atlanticus* Maul, "Oregon," western Caribbean Sea, 1 specimen (Grey, 1960: 67); and 13 hitherto unreported specimens taken off Puerto Rico ("Oregon" sta. 2644, 2645, 2646) and north of the Bahamas "Combat" sta. 235).

Specimens of *Argyripnus* are too scarce in museum collections to allow a determination of the number of species contained in the genus but are numerous enough to show that at least 2 distinct species exist. It is equally clear that each of these 2 forms is variable but the extent and limits of the variation are not determinable. The eastern Atlantic form of *A. atlanticus*, represented by a single specimen, differs from western Atlantic specimens in having a few more anal rays, more posteriorly situated dorsal and anal fins, and a smaller mouth. *A. atlanticus* also inhabits the Pacific at Hawaii as shown above.

The second distinct form of the genus has been found so far only in the Pacific, at Hawaii, the Philippines, and Australia. As shown in Tables 1–3 these Pacific specimens show variation that may indicate specific distinction. *A. ephippiatus* Gilbert and Cramer, from Hawaii, has fewer pectoral rays than other Pacific specimens. *A. iridescens* McCulloch, from Australia, is deeper bodied than other Pacific speci-

TABLE 3

PROPORTIONS OF *Argyripnus* SPECIES EXPRESSED IN PER CENT OF STANDARD LENGTH

SPECIMENS	STANDARD LENGTH	DEPTH	HEAD	SNOUT	ORBIT	UPPER JAW
A. atlanticus, juv. Hawaii	27–27.5	18.0–20.4	—	—	—	—
A. atlanticus, juv. Hawaii	35.5	22.5	30.9	5.62–7.02	*ca.* 11.3	—
A. atlanticus, type[1] eastern Atlantic	56	26.3	30.0	—	—	—
A. atlanticus western Atlantic	55–71	23.2–*ca.* 27.6	*ca.* 28.7–*ca.* 31.9	*ca.* 5.0–6.8	10.5 to 12.1–12.9	19.0 to 20.4–21.2
A. ephippiatus Hawaii	72	—	—	—	—	—
A. ephippiatus, type Hawaii	75	26.0	*ca.* 32.0	6.65–7.32	12.0	23.3
A. ephippiatus Hawaii	80	25.6	26.2	*ca.* 6.86	13.7	22.5–25.1
A. iridescens[2] Australia	90–135	29.6	30.6	6.8	11.65	—
Argyripnus sp. Philippines	82	26.2	34.7–35.3	6.7–7.3	12.8	23.2

SPECIMENS	SNOUT TO DORSAL ORIGIN	SNOUT TO ANAL ORIGIN	SNOUT TO VENTRAL BASE	FIRST ANAL RAY TO CAUDAL BASE	LAST ANAL RAY TO CAUDAL BASE	LAST DORSAL RAY TO CAUDAL BASE
A. atlanticus, juv.	—	44.5–46.2 or 43.6–45.5	—	54.5 or 55.5	—	—
A. atlanticus, juv.	*ca.* 47.8	43.6	*ca.* 35.2–36.6	52.0–53.5	*ca.* 18.3	*ca.* 42.2
A. atlanticus eastern Atlantic	49.0	55.0	43.6	—	—	—
A. atlanticus western Atlantic	46.3–49.0[3]	46.3–47.2 to *ca.* 52.7	*ca.* 39.6–43.1	48.6 to 52.5–53.5	*ca.* 16.4–18.7	39.4 to 43.2–44.0
A. ephippiatus (72) Hawaii	—	—	—	—	—	—
A. ephippiatus, type Hawaii	41.4	54.5	46.0	48.6	17.3	*ca.* 43.4
A. ephippiatus (80) Hawaii	45.0	55.6	44.4	48.7	14.4	*ca.* 41.8
A. iridescens Australia	—	—	—	—	—	—
Argyripnus sp. Philippines	46.4	*ca.* 55.5	46.4	46.4	15.2	*ca.* 41.5

SPECIMENS	LEAST DEPTH OF CAUDAL PEDUNCLE	DORSAL BASE	ANAL BASE	ADIPOSE BASE	PECTORAL LENGTH	FIRST VAV+ AC GROUP TO MIDDLE AC GROUP	MIDDLE AC GROUP TO LAST AC GROUP
A. atlanticus, juv. Hawaii	—	—	—	—	—	—	—
A. atlanticus, juv. Hawaii	7.02–8.45	9.84–11.3	*ca.* 32.3	4.22	18.3–19.7	9.84	9.84–11.3
A. atlanticus eastern Atlantic	11.2	—	—	—	23.2	—	—
A. atlanticus western Atlantic	7.04–9.32	11.9–13.2	30.0–33.9	*ca.* 5.8–10.5	18.9–24.4	3.79 to 5.3–6.0	6.9–9.06[5]
A. ephippiatus (72) Hawaii	—	—	—	—	—	2.78	7.65
A. ephippiatus, type Hawaii	8.65	14.0	*ca.* 31.3	*ca.* 8.0	—	—	8.0
A. ephippiatus (80) Hawaii	9.36	10.85	33.1	10.0	25.0	*ca.* 4.37	*ca.* 8.25
A. iridescens Australia	—	—	—	—	24.3	—	—
Argyripnus sp. Philippines	9.14	12.2	31.5	—[4]	21.9	3.05	7.33

[1] Calculated from measurements given by Maul, 1952: 56.
[2] Calculated from measurements given for a single specimen by McCulloch, 1926: 169.
[3] 42.7 and 43.0–43.9 in 2 specimens 55 and 57 mm. in standard length.
[4] Upper surface of tail damaged, adipose fin lost.
[5] 10.0–10.9 in smallest specimen (55 mm.).

mens and may have more gill rakers, although information on the total number of rakers on the first arch of this species is lacking. The single specimen of *Argyripnus* from the Philippines is unique in a few characters. Because of these unique features and because it is the only specimen to have been caught between Hawaii and Australia, the specimen is not identified to species at the present time, although it was originally labeled *"Argyripnus iridescens"* and is catalogued under that name in the collection of the U. S. National Museum.

A few minor errors appeared in the original description of *A. ephippiatus* (Gilbert and Cramer, 1896: 414) and may be corrected as follows: dorsal rays 11 (not 10); BR (6) (not 5); AC in the most posterior group (15) on the left side and (14) on the right side; adipose fin present and undamaged.

The smallest of the 3 specimens of *A. ephippiatus* examined is bent and cannot be measured accurately. The photophores of this specimen and of the holotype are intact, but many of those of the largest specimen are lost (abdomen and ventral portion of tail damaged). In all 3 specimens the tail is a little shorter than the trunk; the anal origin is below the end of the dorsal fin; there is a distinct gap, filled with membrane, between the two groups of anal rays in the holotype and the smallest specimen; the unbroken pectoral fin of the largest fish extends to a point half-way between the ventral and the anal fins. The pseudobranchiae are well developed; on the inner edge of the first gill arch is a series of groups of minute spines and 1 or 2 slightly enlarged spines on the upper limb near the angle. The maxillary reaches the posterior margin of the orbit; 1 or 2 very small teeth are present on each side of the vomer; and on each palatine, anteriorly, are a few still smaller teeth. *A. ephippiatus* differs from *A. atlanticus* in having fewer gill rakers and fewer photophores in the ventral series. It is unique in its lower pectoral count and in having 1 or 2 slightly enlarged spines on the inner edge of the upper limb of the first gill arch.

The specimen from the Philippines has the tail a little shorter than the trunk; the anal origin is below the end of the dorsal fin; there is a short gap between the two groups of anal rays, situated below the third organ of the middle AC group of 5; the pectoral fin extends slightly beyond the ventral base; the back is damaged and the adipose fin is lost. The pseudo-

KEY TO SPECIES OF *Argyripnus*

1a. Anal origin below first few dorsal rays, or slightly anterior to dorsal origin. Gill rakers on first arch 17–19 + 5–7 = 22–26. VAV + AC (24–28) + (5) + (16–18) = 46–51. IC 62–67 ..... *A. atlanticus* Maul
North Atlantic, Hawaii

1b. Anal origin below posterior half of dorsal fin. Gill rakers on first arch 12–16 + 4–6 = 16–19 (20 + ?).[2] VAV + AC (18–21) + (5) + (12–15) = 35–40. IC 51–56.

2a. Gill rakers on lower limb of first arch 13–16. First group of VAV + AC (19–21). IC 53–56. Head 2.6 to *ca.* 3.8 times in standard length.

3a. Pectoral rays 16–17. Depth 3.1–3.4 times in standard length. Orbit 2.5–2.7 times in head length ..... *A. iridescens* McCulloch
Australia

3b. Pectoral rays 15. Depth 3.8–3.9 times in standard length. Orbit 1.9–2.25 times in head length ..... *A. ephippiatus* Gilbert and Cramer
Hawaii

2b. Gill rakers on lower limb of first arch 12. First group of VAV + AC (18). IC 51. Head 3.85 times in standard length (depth 3.8 times in standard length. Orbit 2.7–2.75 times in head length) ..... *Argyripnus* sp.
Philippines

[2] *A. iridescens* with 16 on lower limb; number on upper limb, and total count, unknown.

branchiae are well developed; on the inner edge of the first gill arch is a series of minute spine-clusters but no enlarged spines are present. The maxillary extends to the posterior margin of the orbit; 1 tooth is present on each side of the vomer; 1 minute tooth can be seen anteriorly on each palatine. This specimen differs from *A. atlanticus* in the same characters that distinguish *A. ephippiatus* from that species. It is unique in its low gill raker and photophore counts and its relatively large head.

A description of the western Atlantic specimens of *A. atlanticus* is being published elsewhere.

REMARKS ON MAUROLICID GENERA

The discovery of 2 young specimens of *Argyripnus* and of a new maurolicid genus requires a partial revision of my key to gonostomatid genera published in 1960. Until relationships within the family are better understood, a number of monotypic genera are maintained, however reluctantly, although some of them may prove to be synonymous. For example, *Thorophos, Neophos,* and *Araiophos* may represent 3 species of a single variable genus, but until the characters separating them can be shown to be of specific rather than of generic value it seems advisable to place them in separate genera. Larger series of specimens, the discovery of postlarval stages, and possibly an understanding of their ecology should one day provide the basis for a more definitive classification. In the meanwhile *Neophos* remains separate from *Thorophos* principally on the basis of the biserial premaxillary teeth; the only other genera in the family with 2 rows of teeth on the premaxillary bones are *Yarrella, Triplophos,* and *Polymetme. Neophos* also differs from most maurolicids in having a body form similar to that of several nonmaurolicid genera; only *Araiophos,* among maurolicids, is similarly slender-bodied anteriorly and thus atypical of the group with which it is classified. *Araiophos* is unique in the form and arrangement of the IV photophores, which consist of 2 minute grouped organs on the isthmus, and on the abdomen four large, well-separated organs preceded by a group of 3 tiny photophores and followed by a group of 2 small ones. The abdominal IV show no such differentiation in any other genus in the family.

The 2 genera *Sonoda* and *Argyripnus* may also prove to be synonymous. *Sonoda paucilampa* Grey (1961), a species found recently in the western Atlantic, is in some respects intermediate between the 2 genera; and the discovery at Hawaii of an *Argyripnus* with the anal origin anterior to the dorsal origin, as it is in *Sonoda,* further narrows the gap between the 2 genera.

Material used in the preparation of the following key, in addition to that reported here and in 1960, included a single damaged specimen of *Thorophos euryops* Bruun from "Dana" sta. 3736-v, 9° 17′ N., 123° 58′ E., 28 June 1929, 1000 m. of wire out; and 6 specimens of *Neophos nexilis* Myers, USNM no. 151400, from off Mindanao, Philippines, "Albatross" sta. 5516, 8° 46′ N., 123° 32′ 30″ E., 9 August 1909, 175 fathoms (320 m.).

KEY TO MAUROLICID GENERA OF GONOSTOMATIDAE

1a. AC composed mostly of separate photophores, more or less evenly spaced, usually one or two groups of 2–4 small organs included (always at least 3 separate organs).

2a. Anal origin in advance of dorsal origin. Ventral bases well ahead of dorsal origin. IV on isthmus straight, none curving upward posteriorly. Total number of AC 7–15. IC 22–37. Dorsal rays 8–14. Anal rays 28–38. Gill rakers on first arch 13–15 + 3–5 = 18–19, 2 in angle.

3a. Maxillary reaching to or beyond posterior margin of eye. Anus closer to anal fin than to ventral bases. Dorsal rays 8–11. Anal rays 31–38. OP 3. SO present. Number of IV on isthmus 6, IV present below pectoral base, total number of IV 17. AC present above the most anterior anal rays, total number 13–15. IC 35–37. OA present. (AC mostly single.)

4a. Premaxillary teeth biserial. Lower jaw teeth biserial in anterior half. Dorsal origin about in middle of body length. No adipose fin. Dorsal rays 8–9. Anal rays 38. IV on isthmus 1 + (2) + (3) = 6. VAV 1 + (3) + 1 = 5. OA 1 ..... *Neophos* Myers

4b. Premaxillary teeth uniserial. Lower jaw teeth uniserial?[a] Dorsal origin slightly behind middle of body length. Adipose fin present. Dorsal rays 11. Anal rays 31. IV on isthmus 3 + (3) = 6. VAV (5). OA (2) + 5 = 7..... ..... *Thorophos* Bruun

3b. Maxillary reaching slightly past middle of eye. Anus half-way between ventral bases and anal origin or slightly nearer ventral bases. Dorsal rays 13–14. Anal rays 28–29. OP 1. SO absent. Number of IV on isthmus (2), no IV below pectoral base, total number of IV 11. AC absent above the most anterior anal rays, total number 7–8. IC 22–23. No OA. (Dorsal origin well behind middle of body length. Adipose fin present.) ..... ***Araiophos,*** new genus

2b. Anal origin behind or below last dorsal ray. Ventral bases below dorsal fin. IV on isthmus curving upward posteriorly. Total number of AC 22–26. IC 45–49. Dorsal rays 6. Anal rays 24–25. Gill rakers on first arch 10–12 + 1 + 2 = 13–15, only 1 in angle. (Dorsal origin well in advance of middle of body length. Anus about half-way between ventral bases and anal fin or slightly nearer anal. Adipose fin present or absent. SO absent. Total number of IV 18, (3) + (4) on isthmus. AC present above the most anterior anal rays. Vertebrae 38.) ..... *Danaphos* Bruun

1b. AC composed of 2 to 5 groups of 2 or more photophores each (1 separate organ present anteriorly only in *Maurolicus*). (Two gill rakers in angle of first arch.)

5a. AC in 3 to 6 groups of 2 to 4 small photophores each. IV (3) + (4) on isthmus, (16–17) on abdomen, total 23–24. VAV (4–5). Gill rakers on first arch 12 + 2–3 = 14–15. (Anal origin below or slightly in advance of dorsal origin. Adipose fin present. Anus closer to anal origin than ventral bases. No SO. No AC above the most anterior anal rays. Vertebrae 32–33?.) ..... *Valenciennellus* Jordan and Evermann

5b. AC in 2 or 3 groups of 5 or more photophores each. IV (6, rarely 7) on isthmus, (10–13) on abdomen, total 16–19. VAV (6–8), *or* joined to anterior group of AC (*Argyripnus*). Gill rakers on first arch 12–22 + 3–8 = 16–30.

6a. Anus about half-way between ventral bases and anal fin or nearer ventrals. Dorsal origin about in middle of body length. SO absent. Lower posterior OP greatly enlarged. IV (6, rarely 7) + (10, rarely 9 or 11) = 16 (rarely 15 or 17). Total number of OA 6–7.

7a. No adipose fin. VAV (7–8), well separated from AC. AC in 2 long groups or 3 short groups, absent above the most anterior anal rays. Dorsal rays 8–9. (Vertebrae 40 and ?.) ..... *Sonoda* Grey

7b. Adipose fin well developed. VAV grouped with photophores above the most anterior anal rays, this group numbering (18–28) in adult. Dorsal rays 10–14. (Vertebrae 47 and ?.) ..... *Argyripnus* Gilbert and Cramer

6b. Anus near anal fin. Dorsal origin well behind middle of body length. SO present. Lower posterior OP of normal size. IV (6) + (12–13) = 18–19. Total number of OA 9 (rarely 10). (Adipose fin present. AC present above the most anterior anal rays, in 2 groups of (14–18) and (7–9) photophores, preceded by a single elevated organ. Vertebrae 32–33.) ..... *Maurolicus* Cocco

[a] Premaxillary and lower jaw bones lost from only specimen of *Thorophos* examined.

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Amorphous Mineral Colloids of Soils of the Pacific Region and Adjacent Areas[1]

YOSHINORI KANEHIRO[2] and LYNN D. WHITTIG[3]

THE PRESENCE of amorphous mineral colloids in soils and geologic formations is not as uncommon as was first believed in the early years following the acceptance of the clay mineral concept. In the early reports the occurrence of amorphous material was associated with only a few rare and isolated clay materials. Because amorphous colloids are not the major component in most soils and their presence may be found in relatively low concentrations, if found at all, their detection has been difficult. Moreover, whereas crystalline clay minerals are relatively uniform in composition, the amorphous materials exhibit a varying degree of composition and poor degree of crystallinity, further adding to the difficulty in their identification. Often their presence has been suggested only because mineral allocations of crystalline materials failed to add up to 100 per cent. In recent years improvement in the use of techniques such as X-ray diffraction, infrared absorption, electron microscopy, and surface area determination, has made it possible to make significant progress in the study of amorphous colloids.

Much of the research dealing with amorphous mineral colloids in soils has been conducted by soil scientists working in the Pacific region or in its adjacent areas. The leadership in this field definitely belongs to this group of researchers. It is the object of this paper to review and discuss the contributions of these workers in order to obtain a better perspective of this very important fraction of soils. These investigators have pointed out that the amorphous constituents make up a sizeable fraction in many soils occurring in Hawaii, Japan, New Zealand, Oregon, and other Pacific areas. These amorphous mineral colloids play a prominent role in soil formation and also impart certain distinctive and unique properties to the soil. Thus, a review of this nature appears justified.

NOMENCLATURE OF AMORPHOUS COLLOIDS

The isolation and description of amorphous colloids have been difficult because of the great variability in materials. Moreover, early samples classified as "amorphous" were actually found to be finely crystalline with modern X-ray diffraction methods. Stromeyer and Hausmann first used the name allophane to describe amorphous material lining cavities in marl in 1816. Since that time many related materials have been called allophane and this term has become associated with amorphous constituents of clay. Ross and Kerr (1934) described allophane as essentially an amorphous solid solution of silica, alumina, and water having no definite atomic structure, and they applied the term allophane to a great number of amorphous clay materials regardless of their composition. They studied five specimens of allophane, all essentially hydrous aluminum silicates, and found that SiO_2 ranged from 25 to 34 per cent, Al_2O_3 from 30 to 36 per cent, and H_2O from 31 to 38 per cent. The New Zealand workers (Fieldes *et al.*, 1952, 1954; Birrell and Gradwell, 1956) have used the term amorphous colloidal hydrous oxides apart from the term allophane in their description of amorphous clays. With allophane, which is considered to be one of the most important amorphous minerals, Fieldes (1955, 1956) has preferred to recognize three distinct

[1] This paper is based on part of a joint report by members of the Clay Mineralogy Work Group of the Western Soil and Water Research Committee. Manuscript received October 3, 1960.

[2] Department of Agronomy and Soil Science, University of Hawaii, Honolulu.

[3] Department of Soils and Plant Nutrition, University of California, Davis, California.

forms: allophane A, allophane B, and the intermediate form, allophane AB. In classifying the clay minerals Grim (1953) has included only the allophane group under the amorphous clay minerals. Brown (1955) in his proposed nomenclature has divided the amorphous minerals into oxides, silicates, and phosphates. In this system, allophane is included in the silicates.

OCCURRENCE OF AMORPHOUS COLLOIDS

Kelley and Page (1943) in their mineralogical investigation encountered two soils from Naalehu and South Point on the island of Hawaii that exhibited very high cation exchange capacities, 120 m.e. and 88 m.e. per 100 g., respectively. They reported that differential thermal analysis showed pronounced endothermic peaks at 160° C. for these two soils in addition to showing weak X-ray diffraction patterns. These investigators, therefore, concluded that the high cation exchange properties were related to the presence of considerable amorphous material. Included in this study were soils from Vale, Oregon, and the Mojave Desert, which also gave very indistinct X-ray lines and showed low temperature breaks, inferring the presence of amorphous material.

Dean (1947) in his D.T.A. study of a number of Hawaiian soils derived from ash and lava found that many of these soils contained almost no crystalline clay minerals. In addition some showed almost no hydrous oxides. It was previously shown by Ayres (1943) that some of these same soils possess very high inorganic cation exchange capacities. Dean concluded that it was possible that some of these soils contain alterations of the kaolin minerals.

Tanada (1950) divided Hawaiian soils into five groups on the basis of chemical analyses and dehydration studies. He obtained similar high cation exchange capacity values for the two soils, Naalehu and South Point, that Kelley and Page (1943) had previously reported. However, Tanada did not draw any conclusions regarding the cause of such high values.

Tamura, Jackson, and Sherman (1953) employed X-ray, chemical, thermal, and infrared techniques and found up to 30 per cent allophane in the less than 0.2 micron fraction of two hydrol humic latosols from the island of Hawaii. The authors noted that the allophane found in the subsoil of one of these soils was very similar to allophane from Woolwich, England (Kerr, 1951). Gibbsite and goethite were reported to make up the bulk of the remaining clay fraction. They also investigated the low humic latosols and reported that the dominant minerals are of the kaolin family. Up to 10 per cent allophane was found to occur in the clay fraction of this group of soils.

In a subsequent paper (1955) the same authors reported on a humic ferruginous latosol from the island of Maui which showed that almost 30 per cent of the clay fraction in the subsoil was composed of allophane.

The occurrence of allophane in some soils of northwestern Oregon was suggested by Whittig *et al.* (1957). These soils, members of the Cascade and Powell series, contained relatively high percentages of alkali-soluble silica and alumina. The amorphous alumino-silicate in these soils was formed by weathering of aeolian volcanic ash.

In earlier work, Whittig (1954) reported the occurrence of a more stable form of allophane in two humic ferruginous latosols of Hawaii. The allophane of these soils had a relatively low cation exchange capacity (of the order of 10 m.e. per 100 g.) and resisted solution in boiling Na_2CO_3 solution.

More recently Bates (1961) described the presence of mineral gels in Hawaiian soils which are mixtures of aluminum, iron, silica, and titanium compounds. The gel material is very reactive chemically and gives rise to inorganic and organomineral complexes in the colloid fraction.

Matsusaka and Sherman (1960) have reported that the iron hydroxide and oxide of the amorphous mineral colloid fraction of Hawaiian lateritic soils will form strongly magnetic iron oxides on dehydration. This may help explain the magnetic properties of weathered ferruginous geological formations.

In Japan Sudo (1954), Sudo and Ossaka (1952), and Aomine and Yoshinaga (1955) have pointed to allophane as the dominant constituent of Ando soils which are formed from volcanic ash. These soils are characterized by a

low bulk density, a high organic carbon content, and low base saturation. These properties are attributed to the preponderance of allophane. The Ando soils and related types are found associated with the Pacific ring of volcanic activity. These Japanese workers have found that the fine clay fraction of the Ando soils is characterized by being amorphous to X-rays and possesses medium-to-high cation exchange capacities and high phosphate- and ethylene glycol-retention values.

The New Zealanders have also worked extensively on the identification of amorphous constituents. In 1952 Birrell and Fieldes (1952) and Birrell (1952) identified the presence of amorphous material, principally allophane, in soils derived from rhyolitic and andesitic ash. The allophane was found to be present mainly in the clay fraction although it was inferred that it was present to some extent in the silt fraction. These soils were characterized by a high water-holding capacity, high shrinkage, and irreversible drying, characteristics that are strikingly common to many other Pacific region soils dominated by allophane. Birrell (1952) also pointed out that these soils had a waxy appearance and were greasy to the feel, yet they were not unusually sticky. He further noted that associated with nonreversible drying, liquid and plastic limit values were much greater for undried soils than for dried soils.

Later reports, especially by Fieldes and his co-workers (1955, 1956, 1957, 1955), have confirmed that allophane and other amorphous constituents dominate many New Zealand soils derived from volcanic ash and, in some cases, basaltic parent materials. These workers utilized electron microscopy, differential thermal analysis, and infrared absorption extensively in identifying the presence of amorphous constituents.

PEDOGENIC SIGNIFICANCE OF AMORPHOUS COLLOIDS

Ross and Kerr (1934) described allophane as an amorphous hydrous aluminosilicate having no definite chemical composition and that it is commonly associated with halloysite. They were careful to point out that it is not a microscopic mixture of amorphous silica and alumina. Kerr (1951) offered confirmatory evidence by absorption spectra that allophane is not a mixture of alumina and silica.

Tamura *et al.* (1953) assigned allophane to weathering stage 11 or the gibbsite stage in the weathering sequence of clay-size minerals as presented by Jackson *et al.* (1948). They noted that the trend for increased gibbsite with increased rainfall is very marked in passing from the low humic latosols to the hydrol humic latosols. With this increase in gibbsite is an associated increase in allophane.

A mechanism for the transition of alumina and silica through allophane to kaolin was proposed by Tamura and Jackson (1953). The steps are as follows: (1) amorphous hydrous alumina crystallizes to a gibbsite structure; (2) with partial dehydration, hydroxyls in the gibbsite octahedra are replaced by oxygens of the silica tetrahedra; (3) this process occurs in the presence of silica solutions and continues through entrance of silica between gibbsite sheets, resulting in a cross-linking of silicated octahedral sheets of alumina which corresponds to allophane; (4) kaolinite is formed from allophane on completion of unidirectional bonding through alternate wetting and drying in an acid medium where enough silica is available.

The stable, nonreactive form of allophane reported by Whittig (1954) as a constituent of some humic ferruginous latosols of Hawaii was considered to be a weathering product of halloysite. Electron micrographs of clay fractions of these soils revealed a transition from well-developed halloysite rod structures to spherical, X-amorphous allophane particles. It was suggested that partial removal of silica from the rigid halloysite rods by leaching allowed the rods to curl up in a direction perpendicular to their original curvation. Allophane formed in this way possessed properties quite different from those of the more labile allophane described by Tamura and Jackson (1953) and would occupy a lower position in the weathering sequence of Jackson *et al.* (1948).

More recently Bates (1960) suggested that the development of allophane is a logical stage in the weathering of certain Hawaiian volcanic ash and also in the matrix of rock. In other cases, he indicated that allophane is an inter-

mediate stage in the weathering sequence of halloysite to gibbsite. Bates also reported the formation of gibbsite crystals upon dehydration of amorphous Fe-Al gels. This observation supports Sherman (1957), who reported that crystalline gibbsite aggregates formed when the soils of the Hydrol Humic Latosol group were air dried. These soils have a high content of amorphous mineral colloids which contain a substantial amount of gel material.

Some of the Japanese workers (Sudo, 1954; Sudo and Ossaka, 1952) conclude that allophane precedes halloysite in the weathering sequence from ash to allophane to halloysite. Aomine and Yoshinaga (1955) have also emphasized that the clay fraction of the volcanic ash soils of Kyushu and Hokkaido formed under similar well-drained conditions is predominantly allophane, regardless of differences in temperature, weathering time, vegetation, and ash origin.

The New Zealanders have also tried to properly position the amorphous materials in the weathering sequence. Fieldes and Swindale (1954) have prepared a flow sheet tracing the mechanism of silicate minerals weathering. They have proposed that the nature of the clay constituents of any soil can be predicted if its parent material and weathering stage are known. The amorphous materials occupy a great role in this flow sheet in that it is thought that the primary silicates (aside from the micas) cannot form layer silicates without first passing through an amorphous stage. Clays derived from rhyolitic and andesitic ash pass through the weathering sequence from amorphous hydrous oxides through allophane to meta-halloysite and kaolin. It is believed that many of the Hawaiian soils derived from andesitic ash follow this same sequence.

In an earlier paper Fieldes *et al.* (1952) emphasized that the amorphous hydrous oxides played more than a brief transitory role. They reported some soils of the lower Cook Islands which showed high cation exchange capacity values. These soils were all low in silica, and also allophane was not found to be a constituent in them. They attributed the cation exchange capacity mainly to the amorphous hydrous oxides.

In later papers Fieldes (1955, 1956, 1957) reported enough fundamental differences in allophane to warrant recognizing three types: allophane A, allophane B, and the intermediate type, allophane AB. Based mainly on infrared absorption data, it was found that silica is linked with alumina to form allophane A while some silica is discrete as amorphous hydrous silica in allophane B. Fieldes could offer no satisfactory explanation as to why co-precipitation and linking of alumina and silica occur to only a limited extent in allophane B. He did not want to state that allophane B is simply a mixture of amorphous alumina and silica. Differential thermal analysis shows that a high temperature exotherm between 850° and 1000° C. is strong in allophane A, not present in allophane B, and weakly developed in the intermediate form, allophane AB. Fieldes (1955) has presented a weathering sequence of clays derived from rhyolitic and andesitic ash: allophane B—allophane AB—allophane A—meta-halloysite—kaolinite. He has stated that in this sequence the stable form is meta-halloysite and progress towards this stable form through allophane A is consistent with the mechanism proposed by Tamura and Jackson (1953). The structure consisting of hydrous alumina octahedra randomly crosslinked by silica tetrahedra and called allophane by Tamura and Jackson would hence correspond to allophane A as proposed by Fieldes.

There is a growing consensus among investigators in this field that amorphous colloids may play a very important role in soil formation and in establishing properties of many soils of the continental United States as well as in the Pacific islands. Because of their noncrystalline nature, identification of allophane and other amorphous constituents is at present very difficult, and at best very unreliable, by standard methods of analysis unless they be present as predominant components of their system. In view of the fact that transition from primary silicates (with the exception of micas) to the secondary layer silicates must include some solution and reprecipitation, it is reasonable to suspect that amorphous colloids exist, at least as a transition stage, in most of our soils. The extent of their presence is masked in most of our mineralogical studies by the crystalline components present.

The fact that amorphous colloids greatly affect properties of soils where they are dominant constituents emphasizes the need for more critical examination of our soils for evidence of their presence. According to Kanehiro and Sherman (1956), it is well established that allophane has low bulk density, high water-holding capacity, and, in some cases at least, a high cation exchange capacity. In addition it has been observed that allophane has a strong aggregation effect on soils, a very high phosphate fixing capacity, and the ability in some cases to fix organic compounds so as to render nitrogen available with difficulty to microorganisms and higher plants (T. Sudo, private communication).

Early researches of Burgess and McGeorge (1926) and Burgess (1929) in Arizona suggested that amorphous alumina, silica, or aluminosilicate may be formed quite readily in soils by application of alkaline solutions. Kerr (1928) further postulated that amorphous aluminosilicates may form even in slightly acid soils as a result of local hydrolysis of feldspars, solution of alkaline silicates and aluminates, and subsequent co-precipitation.

The Pacific region and its adjacent areas, with their recent volcanic materials offer a splendid opportunity for investigation of the presence of, the properties imparted by, and the mechanisms of formation of, such amorphous constituents in soils.

SUMMARY

The work on the amorphous mineral colloids of soils of the Pacific region and its nearby areas is described.

The amorphous colloids, especially allophane, dominate the clay fraction of many soils derived from volcanic ash, as well as some rocks, in the Pacific area. Soils dominated by these amorphous colloids have many distinct and unique properties. The position of the amorphous colloids, especially of allophane, in the weathering sequence remains to be fully clarified.

For many reasons, the identification of amorphous colloids is often difficult; however, recent improvements in instrumental techniques have greatly facilitated this identification.

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NOTE

Daylight Surface Occurrence of Myctophid Fishes Off the Coast of Central America

FRANKLIN G. ALVERSON[1]

THE CAPTURE off the coast of Central America of *Benthosema pterota* (Alcock, 1891), by California-based tuna clippers, on three known occasions, at the surface during daylight hours is worthy of note. Myctophids are ordinarily believed to be bathypelagic in nature and associated with the twilight zone of the sea. The fact that myctophids make nocturnal migrations to the surface has long been known and many specimens have been taken at the surface during the hours of darkness.

The first daylight capture of *Benthosema pterota* was recorded 13 mi. west of Cape Blanco, Costa Rica, on March 14, 1952, by the tuna clipper "Anna M." The fish were taken with a dip net at 1300 on a clear day from the fishing racks of the vessel. The water was clear and the surface temperature was 82.5°F. The skipper, Ted Sorensen, reported three "balls" of reddish-brown bait at the surface with yellowfin tuna (*Neothunnus macropterus*) feeding voraciously on them. The fish, as described by Sorensen, were in tight elliptical aggregations measuring about 10 ft. in length and 3 ft. in depth. The tuna feeding upon the myctophids refused the fish (*Cetengraulis mysticetus*) used by this vessel for live bait when it was offered to them.

A second capture of the species at the surface during daylight hours was reported by a crew member of the tuna clipper "Sun Traveler"; the capture was made on March 15–20, 1954, 65 mi. southwest of Caño Island, Costa Rica. Mr. Joseph Silva observed the fish at 10:00. They also appeared as a reddish-brown "ball" being fed on by skipjack (*Katsuwonus pelamis*), yellowfin tuna, and sea birds. Four other small schools were seen in the same locality. The clipper left the immediate area at this time and returned at 16:00 the same day. At this time, the schools of myctophids were still on the surface and when the vessel drew close they took shelter under the stern, evidently for protection from the yellowfin and skipjack. Specimens were easily captured with a dip net from the racks on the stern of the vessel.

A third occurrence of this species on the surface during daylight hours was noted on April 7, 1955, at 13° 19′ N. and 91° 16′ W. by the crew of the tuna clipper "Commadore." The fish were again captured with a dip net from the stern of the vessel while it was fishing for yellowfin. The fish again appeared as reddish-brown "balls" on the surface.

The table below gives the size range and mean standard length for the three samples of *Benthosema*.

Although only three samples have been obtained by the author, apparently the sighting by fishermen of myctophid schools on the surface during daylight hours in the spring of the year is not uncommon. Mr. Edward Silva, managing owner of the "Santa Rosa," says that fish fitting the description of myctophids have been taken by clippers and attempts made to use them as tuna bait. However, the fish scaled easily, were weak, and were unsatisfactory for bait. Mr. Manuel Luz, former skipper of the "Saratoga," said he has seen many small "balls" of bait in the waters off Costa Rica during the spring of the year that fitted the same description. He also noted that the fish made poor bait because they scaled easily and were too weak for retention in the bait wells.

[1] Inter-American Tropical Tuna Commission, La Jolla, California.

NO.	DATE OF CAPTURE	NO. MEASURED	MEAN STANDARD LENGTH (mm.)	RANGE IN STANDARD LENGTH (mm.)
1	March 14, 1952	49	39.0	35–47
2	March 15–20, 1954	43	46.3	38–54
3	April 7, 1955	50	35.2	32–40

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